THE GLASS INDUSTRY

VOLUME 28, NUMBER 1, JANUARY, 1947

SEMI-ANNUAL MEETING OF G. C. M. I. AGAIN HELD IN MIAMI

The Sea Isle Hotel in Miami Beach, after a lapse of just one year, again played host to the Glass Container Manufacturers Institute on the occasion of its Semi-Annual Meeting held during the week of December 2.

Since the Annual Meeting which was scheduled to be held during last May at the Hotel Hershey in Hershey, Pennsylvania, had to be postponed due to the then existing coal miners strike, the Miami meeting was the first time the entire membership had been assembled in a year's time.

The Meeting was called to order on Monday, December 2, by the Institute's President, George F. Lang, President of the Carr-Lowrey Glass Company.

Two new trustees were elected to the Board of Trustees, namely, Joseph C. Feagley, who will fill the place of Francis H. May, whose term expires this year, and Charles D. Rau, who has been serving as a trustee, filling in the unexpired term of his brother, the late John H. Rau. George R. Lang whose term expired in 1946 was reelected to the Board. Robert L. Warren was elected first vice president taking the place of Mr. May and I. R. Macdonald of Dominion Glass Co., Ltd., was elected second vice president.

Following the opening remarks of President Lang, reports of the Chairmen of the Institute's nine Standing Committees were presented and the first of these reports came from Louis C. Roche of the Maryland Glass Corporation and Chairman of the Committee on Labor Relations. Following Mr. Roche's report, Ralph A. Lind, Secretary and Labor Counsel of the Institute's Labor Relations Committee, discussed the industry's labor relations from the long haul point of view. Fred E. Fuller, general counsel to the G.C.M.I., also discussed certain aspects of the labor situation.

The period covered by Mr. Roche's report was from December 1945 through November 1946.

Labor Relations

It was evident from Mr. Roche's report that he and his Committee have worked with vigor and intelligence in connection with labor matters confronting both the Glass Bottle Blowers' Association and the American Flint Glass Workers' Union.

In his concluding remarks, Mr. Roche mentioned that Charles B. Garwood, of the Carr-Lowrey Glass Company, had requested that he be relieved of his duties as a member of the Labor Committee. The reason for his resignation was the condition of his wife's health. Mr. Garwood has had many years of experience in labor negotiation and Mr. Roche emphasized the fine advice and help the Committee on Labor Relations had received from Mr. Garwood as a result of his broad experience. Mr. Roche also stated that Robert E. Board, of the Foster-Forbes Glass Company, had been added to the Labor Committee.

Traffic

The report of the Traffic Committee was presented by B. H. Taylor, Traffic Director of the Glass Container Manufacturers Institute. The subject of traffic is extremely involved and difficult to follow. Hence, the following presents only a few highlights of Mr. Taylor's talk.

In its first semi-annual report to the Board made just a year ago, the committee said that the late war had brought about a complex problem of adjustment to post-war transportation conditions, the ultimate course of which, at that time, was none too certain. In commenting on the aspects of post-war transportation, Mr. Taylor said the direction any legislative change in the national transportation policy may take is still not clear, but with respect to the pricing of transportation services, the adjustment is taking definite form. He pointed out that at no time, since passage of the first Interstate Commerce Act more than 50 years ago, have there been as many formal cases involving practices of common carriers and pending revisions in the freight rate structure of the country before State Utility Commissions, the Interstate Commerce Commission and the courts for adjudication

as now. Virtually all of them are designed to make transportation service more costly.

With regard to orders of the Interstate Commerce Commission in Dockets Nos. 28300 and 28310, Mr. Taylor said that since the Committee's last report, the Federal District Court for the Northern District of New York had dissolved its temporary interlocutory injunction enjoining the Interstate Commerce Commission from enforcing its orders in these two proceedings and found that the Commission had the discretion and power to prescribe the conditions it did, but at the same time this Court had stayed execution of its findings so as to afford complainants an opportunity to determine if the United States Supreme Court would review the case. He stated the United States Supreme Court had taken jurisdiction and the case would be argued before it in February next year.

In reporting for the Committee, Mr. Taylor said it had unanimously recommended that the Institute participate in the proceedings before the Interstate Commerce Commission in the railroad's petition for authority to increase freight rates and charges by 25 per cent which proceedings had been designated as Ex Parte 148 and Ex Parte 162. He said it was the view of the Committee that the post-war increase in labor and materials costs of the railroads probably warranted some increase in rates if they were to remain solvent but that such need should be proven by competent evidence. Mr. Taylor said the Board has approved this recommendation and that the Institute had carried it out in the course of which the Commission's attention had been called to phases of the railroad's case which failed to support all of their contentions. He said that in the carriers' petition, they specifically sought an across the board increase of 40c per ton in the rates on glass sand and 20c per ton on common sand and on this part of it the committee had recommended that it be opposed which had been done. An increase of 40c per ton in the rates on glass sand would cost the industry, he said, approximately $1,125,000 per year and that the Institute had contended that the increase on glass sand should not exceed by more than 15 per cent any increase authorized in the rates on common sand and that when the rates were presently the same, there should be no differential. The difference of 15 per cent in the level of rates on the two descriptions of sand has previously been prescribed by the Commission and the hope was expressed that the industry's position with respect to continuing that difference will be conceded when the decision comes out. Should it turn out this way, any increase in rates on glass sand would not cost the industry more than $300,000 annually as contrasted with $1,125,000 as sought by the railroads.

Concerning the carriers' proposal to revise consolidated freight classification Rule 41, which deals with shipping containers, Mr. Taylor stated, "This is not a new subject but is one concerning which a good deal has transpired since the last report of the committee. Despite the well founded and persistent effort that industry generally put forth to prevent it, the three carrier classification Committees docketed for public hearing in May of this year a proposal to strengthen the fibre box manufacturing specifications and to establish a number of objectionable requirements governing interior packing of glass and articles in glass in this rule. The proposal contemplated the publication of requirements which, aside from having little or no merit in affording protection to glass containers and products packed in glass while being transported, would have resulted in added costs to the industry of something like $16,000,000 annually for cartons and inner packing materials. Furthermore, because of the critical short supply of paper, its requirements would have made it necessary, until the supply improves materially, to curtail fibre box production from 15 per cent to 20 per cent. Since the proposal was public docketed, industry was left with no alternative but to express its view at public hearings. Hearings were held at Atlanta, New York, Chicago and San Francisco. The Institute put in its case for the glass container industry at the Chicago hearing.

"Following the last of the public hearings, the three Classification Committees made a report to their respective Traffic Executives. This report set forth, among other things, that the shipping public was universally opposed to the proposal. It also contained three recommendations. One was to continue the present rule until such time as the supply of paper had improved. Another was for these committees to be authorized to join in a cooperative effort with paperboard and fibre box manufacturers, also the users of fibre boxes, in an endeavor to obtain such facts as would permit the publication of an acceptable rule. The third was to permit the Classification Committees to enlarge upon their activities in policing the present rule.

"The Western Executives approved these recommendations. The Eastern and Southern Executives, after a good deal of backing and filling, rejected them and ordered the re-publication, effective December 31, 1946, of the same rule that was in effect prior to the war. The pre-war rule would dispense with weight per thousand square feet of linerboard and restore caliper bases for individual facings.

"It would result in cancellation of the 5 per cent tolerance in weights of linerboard now provided in the rule.

"It would also restore specific requirements for sealing fibre boxes which were eliminated in the present rule.

"Subsequently, the Southern Executives reconsidered their action and are willing now to go along with the Western Executives to extend the present rule until June 30, 1947, with the understanding that the several interested shipping groups now conducting investigations and studies on the adequacy of fibre boxes, of which our industry is one, will be prepared by April 1, 1947, to show what has been accomplished and what can or ought to be done to the rule so as to reduce the cause for damage to cartoned freight while in the custody of the railroads.

"At the time the Committee report was prepared, the Eastern Executives are adhering to their position to restore the pre-war rule now. These Executives have, however, arranged for a conference with shippers and shipping groups to be held in New York November 26 to discuss the subject of Rule 41. Our industry will, of course, be represented at that conference.

"The committee believes it unlikely the Interstate Commerce Commission would permit any substantial change in the rule unless it was for application in all sections of the country."

Later in the meeting, following the presentation of the report of the Committee on Package Design and Specifications, a technicolor motion picture prepared by the

Owens-Illinois Glass Company was shown showing various tests on paper and shipping cartons. This picture was shown before the Classification Committees at the Chicago hearing.

Package Design and Specifications

A. S. Reese, of Tygart Valley Glass Company and Chairman of the Committee on Package Design and Specifications, spoke briefly on the activities of his Committee. He stated, "It is the unanimous opinion of the committee that the problem of packaging products in glass containers is becoming one of increasing importance to the glass container industry and that, consequently, there is a real and immediate necessity for the industry to go forward, with as little delay as possible, with the carton research program it has initiated. This program, the framework of which has had Board approval, has been discussed in previous reports.

"The committee now sees more clearly the objective of this program. It should embrace: 1) The development of more basic information on materials entering into construction of fibre boxes; 2) *a.* The development of improved methods for evaluating serviceability of fibre boxes, and *b.* the development of the most adaptable inner packing materials and manner of use to insure maximum protection to contents of fibre boxes; 3) The development of data for use in formulating recommendations to rail and motor carriers on tariff rules which fix requirements for packaging glass containers and articles in glass containers; 4) The development of information for use in considering the adoption of standards for fibre boxes and inner packing methods; 5) The development of data needed for the preparation of an industry fibre box manual; and 6) The development of facts suitable for use in advising with glass packers on specific packaging problems."

As a part of this work, Mr. Reese stated that, "The facilities of the Preston Laboratories at Butler, Pa., are being used to carry on the program. The committee believes there is a definite relationship in the work being done at this laboratory on glass technology and its new undertaking on fibre box research since both activities are, in the final analysis, designed to achieve the same overall purpose."

He further stated that it has been decided that before the behavior of fibre boxes could be more accurately predicted, a means would have to be found to measure the performance of present boxes. He pointed out that as a part of this study, the question of how the railroads are handling glass packed products must be considered. It is believed that much of the loss and damage presently incurred is attributable to the carrier's method of handling rather than to inherent faults in fibre boxes and inner packing materials and methods.

Testing Procedures

At the start of the Tuesday morning session, Kenneth C. Lyon, of Armstrong Cork Company and Chairman of the Committee on Testing Procedures, presented his report to the Institute's members. As is his custom, Dr. Lyon succinctly outlined the past year of his group, referring members to the minutes of the Committee's meeting and also briefly described the work now in hand.

Concerning research work being carried on, Dr. Lyon stated: "Dr. Glathart, of Preston Laboratories, has been studying the nature of the breakage of glass and his study continues to show satisfactory progress, considering the complexity of the subject. Considerable time has been spent perfecting the necessary equipment for the study and we are hopeful that the next few months will yield something of a reportable nature.

Further on in his report he said, "As I pointed out in my first report to you, the impact strength of glass is very important not only to glass container manufacturers, but also to the majority of producers of glass. From various sources of information, it appears that several persons and organizations are pursuing studies of this property, even though it is a difficult subject. The several angles of approach being followed in the various groups should give us a more comprehensive understanding of the breakage of glass than we now have.

"Dr. Knight's study of a second quick test to use in conjunction with the density test to assist in determining glass composition changes has been delayed, in part, by a difficulty which I am sure you will understand—slow deliveries of equipment."

In connection with the training program, Dr. Lyon stated, "There has been a gratifying response to the training school program carried on under Dr. Ghering's supervision. Seventy-two persons, representing twelve companies, have attended. Additional schools may be scheduled as the demand and Ghering's availability indicate. Because of requests from West Coast companies for training, your Committee is in agreement that Dr. Ghering should carry this service to them, possibly in February.

In closing, Dr. Lyon mentioned two previous reports concerning specifically two items which have either not been completed or discussed further in subsequent reports: 1) filling line simulative testing of containers and 2) release of strain in glass upon breakage

Government and Industry Relations

C. Dudley King, of the Anchor Hocking Glass Corporation, as Chairman of the Government-Industry Committee has had many difficult and involved problems to handle. In presenting a resume of the activities of his Committee, Mr. King stated, "The principal concern of the Committee continues to center on orders and regulations issued by various government agencies affecting glass container and closure manufacturers and raw materials used by those manufacturers. While such controls were instituted for the most part during the war period, others were the result of problems arising out of reconversion to peacetime operation and some were made necessary by the dislocations caused by strikes.

"Whatever the origin or cause of the particular governmental regulation, this Committee has endeavored to insure that no undue or unnecessary hardship would be placed upon glass container and closure manufacturers to the advantage of competing container industries; and, in the case of raw materials, that a fair share of the supply be apportioned or made available to our industries consonant with the interests of the public generally."

In reviewing the effect and status of various government orders affecting the glass container industry, Mr. King pointed out that in the revocation of L-103 in a letter from Fred Glover, Director for Industry Opera-

tions, that "the industry had been collectively and individually requested to preserve the benefits provided in L-103 by refraining from actions that would reduce the output of containers or change the existing pattern of manufacture to the detriment of any packer or consumer group".

Mr. King's report also included mention of his Committee's work in connection with CPA Order M-31, Iron and Steel, and CPA Order M-43, Tin. He outlined the energetic work of his group to secure the necessary requirements for closure metal so as not to endanger the packing of food and health supply items in glass.

With regard to M-43, Mr. King briefly outlined the situation with regard to the supply of pig tin and its effect on the availability of tinplate and tinfoil for metal cap manufacture.

Other activities of his Committee were touched on by Mr. King and he pointed out that since his last semi-annual report to the Board of Trustees, his Committee had issued sixteen bulletins covering thirty-three topics of timely interest to the various segments of the industry.

Standards and Finishes

George M. Stuntz, of Anchor Hocking Glass Corporation and Chairman of this Committee was unable to attend the meeting. Hence, Harry W. Kuni, Secretary of the Committee, presented the report of his Committee. "The Committee has been functioning at full throttle for over a year now and as I view it in retrospect, the activities fall into two categories: a) the review and simplification of standards issued by the Glass Container Association (dissolved) and subsequently adopted by the committee at the time of its formation and b) studies and explorations of an original nature".

Mr. Kuni then went on to outline details concerning the number of standards for finishes in use by the industry and the problems involved in adopting these standards and difficulties encountered in the alteration or revision of a single dimension.

In referring to the fact that a larger number of standards have not been reissued under G.C.M.I. title, Mr. Stuntz stated, "My immediate remarks are for the purpose also of acquainting you with the reason that a larger number of standards have not been reissued under G.C.M.I. title. The Committee is carefully examining each finish for the purpose of 1) determining whether the present specifications are the most satisfactory from the viewpoint of all concerned, the mold maker, glass container and closure manufacturer, packers and the ultimate user of the packaged product; 2) the elimination of sizes that are no longer in demand or in active use in order to reduce the amount of manufacturing equipment required to be maintained by the industry; and 3) the simplification and clarification of the data contained on the standard prints to remove superfluities or ambiguities and make them more readable by shop personnel.

Market Research and Promotion

Edward A. Schrag, of Knox Glass Associates and Chairman of the Committee on Market Research and Promotion, was unable to attend the Miami meeting. Hence, W. W. McElhattan, Sales Manager of the same company, delivered Mr. Schrag's report.

In opening Mr. Schrag's report, it was pointed out that it was originally intended to call a meeting of his Committee prior to the Miami Semi-Annual Meeting but it was felt that such a meeting would not accomplish the desired results at that time.

In anticipation of contemplated promotional work, Mr. Schrag stated that certain statistical data has been obtained.

The report then outlined a number of glass packed items, specifically in the food field, which, it is felt, if properly merchandised in glass could account for a considerable eventual increase in glass container volume.

Container Design and Specifications

This Committee has three sub-committees. One on beer bottles headed by Glen A. Mengle of Brockway Glass Company; another on milk bottles headed by R. M. Lamb, Jr. of Lamb Glass Company. The third sub-committee deals with technical matters and its chairman is Foster Mitchell of Armstrong Cork Company.

Chairman of the Committee in the main is S. B. DeMerrell of Anchor Hocking Glass Corporation. In his report, he stated that the scope and urgency of the work being handled by his Committee has so broadened during the past six months that committee meetings have been scheduled bi-monthly and, during this period, the Technical Sub-Committee has held two meetings.

In his report, Mr. DeMerrell discussed the Revision and Completion of Existing Container Standards, Adoption of New Standards and the compilation of a Manual for Manufacturers of Liquor and Wine Bottles. In connection with this project, he stated, "As I reported to you last May, your Committee felt it could render a service by compiling in one booklet all of the Federal regulations pertaining to the manufacture, sale and use of liquor and wine bottles. Such a manual was compiled and, following approval by the Treasury Department, was issued to the Industry last June. It includes the basic enabling act, Treasury Regulations 13, the Federal Alcohol Administration Regulations and the various interpretations issued under these Regulations. It is interesting to note that the Treasury Department requested 19 copies for use by its supervisors throughout the country.

"Since the glass container plant maangers are affected by only a part of the regulations set forth in the above manual, it was decided to compile for their use a condensed version of the manual. Such a write-up was also issued to the Industry and the comments received indicate that the two documents are proving of real value to the Industry."

Mr. Mengle briefly reported on the work of his sub-committee on beer bottles outlining the results of a meeting with the Brewers' Containers Committee of the U. S. Brewers Foundation and the Small Brewers Committee for the purpose of revising the List of Standards for Beer Bottles adopted as of May 1, 1941. He pointed out that a brochure containing these standards has been released and will be available to all members and contributing companies through the Glass Container Manufacturers Institute.

Mr. Lamb's report for the Sub-Committee on Milk

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METALLIZING GLASS AND CERAMIC MATERIALS

By A. J. MONACK, Engineering Consultant

Any application of metal to a glass or ceramic surface may be called "metallizing". In general usage, however, the term does not apply to the sealing of metal in massive form to a glass or ceramic surface. Thus, a sheet, strip, or disc of very thin copper can be attached to a sheet or block or cylinder of glass by bringing the two in contact when the temperature of each is above the softening temperature of the glass. This is considered a glass-metal seal rather than a metallized surface. The two may be differentiated by stating that metallizing always involves initial application of a thin film composed of discrete metal particles, the film later being increased in thickness, if desired, by further application of the same or another metal.

While the discussion to follow will be chiefly in terms of glass, nearly all methods described are equally applicable to ceramic materials. Glazes and porcelain enamels are glasses; glass-bonded mica is composed partly of glass; porcelains and similar materials contain a glassy matrix. Most of the metallizing processes can be employed with crystals (for example, metal coatings on piezoelectric crystals), and many are used widely on organic plastic materials.

Purposes of Metallizing

Metallizing is performed on glass and ceramics for various reasons. These may be summarized as follows: 1. *Electrical,* a. Conduction, b. Resistance; 2. *Reflective,* a. Optical, b. Thermal; 3. *Sealing,* a. Mounting, b. Hermetic; 4. *Molding;* 5. *Decorative.*

1. *Electrical.* Metal coatings applied to glass may act merely to conduct electric currents or may be resistances intended to serve as such in electrical circuits or as elements intended to become hot through the passage of electric current. Examples of use as conductors are numerous. Among these are metal films on glass and mica in condensers, grounding and shielding coatings for electron tubes and other components in electrical equipment, electrical contacts on resistor units, etc. During the past war extremely small radio receivers and transmitters were made by "printing" the circuit connections as well as certain components on a flat ceramic plate, thus obviating the use of wires. Metal coatings served as the "printing inks". Coatings of the proper metals could also serve as resistances in applications such as the above. On the other hand, resistances can also serve as heating elements on the surfaces of glass and other ceramics, and this use is likely to extend into fields of considerable magnitude, such as heating of homes and commercial structures.

2. *Reflective.* Reflective applications of metal films nearly always involve the use of the metal as a mirror. Silvered mirrors, prisms, reflectors (including the Mount Palomar 200-inch glass disc), and various other optical devices are well-known examples. The Thermos bottle or Dewar flask is representative of what may be called thermal reflection since the prime purpose of the coating is to reflect infra red rays. Actually, there is little or no difference in function in the reflection of infra red, visible light, ultra violet, or high frequency radio waves.

3. *Sealing.* Because of the disparity in thermal expansions of hard glasses, porcelains, and steatites on the one hand and common metals and alloys on the other it is not possible to seal these latter directly into the insulating ceramic. The high maturing temperatures and long firing times of steatite and porcelain are another reason why these cannot be used directly with common metals. Metals such as tungsten, molybdenum, and tantalum, which might possibly be employed are costly, brittle, and easily oxidizable. In order to overcome these problems it is customary to metallize ceramic insulators and solder the metal portions to the insulators, thus obtaining hermetic seals. Transformer bushings and numerous other applications of this type are common.

Much attention at the present time is being devoted to another type of hermetic application, one in which panes of window glass are joined along metallized edges to form a multiple window with enclosed spaces which may be filled with air or other gases which have been freed of moisture.

In some instances a hermetic seal is not required and metallizing is used merely as a means of support. For example, a glass disc with metallized edges may be soldered into the end of a metal tube or a metallized glass tube.

4. *Molding.* Applications of metallizing as a means of molding or forming a metal shape are not numerous. Parabolic reflectors, however, have been made by silvering an accurate glass mold and then electro-depositing copper of the required thickness. Alternate immersions in hot and cold water are used to free the reflector from the glass without the employment of tools which might mar the surface or edges. The silver surface is rhodium plated and polished.

5. *Decorative.* The decorative applications of metallizing require no description. Gold, silver, and platinum have been used for many years in various designs on glassware, china, and other types of utilitarian and art ware. Copper has been used to a limited extent for the same purpose.

Fundamentals of Metallizing

The choice of a metallizing method is generally determined by the properties desired or required in the coating. Very often the choice of a method is determined by the character of the material on which the metal is to be deposited, but this factor is not important in the case of ceramics except for glass-bonded mica or other products composed partly or entirely of low-melting glass. In this instance poor chemical resistance to the action of acids and alkalies requires precautions.

Metallizing methods may be classified into five groups, as follows: 1. *Mechanical films;* 2. *Metallic paints;* 3. *Metal spraying;* 4. *Cathode sputtering and evaporation;* 5. *Chemical reduction films.*

1. *Mechanical films.* This is perhaps the simplest method of applying a metal coating to a non-conductor.

The metal, in the form of fine powder, adheres mechanically to the surface and is not chemically deposited or combined. The bonding medium may be a wax, natural gum, lacquer or varnish, synthetic resin, gelatin, glue, rubber, gutta percha, or asphalt. The bonding medium may be applied to the surface to be coated and the metal subsequently deposited or the bonding medium may be mixed with the metal and the mixture applied to the surface.

Mechanical films are generally employed merely as conducting coatings upon which metals can be deposited by electroplating. In certain instances, however, the mechanical conducting film is complete in itself. This is true, for example, when the metal is applied to test specimens as electrodes in measurements of conductivity and dielectric properties.

Because of the poor scratch resistance of mechanical films and their general fragility these coatings find no application for decorative purposes unless covered by stronger coatings of metal, as by electroplating, or by transparent protective films.

2. *Metallic paints.* Metallic paints differ from mechanical films in that the former are subjected to elevated temperatures after application to the glass surface. The firing may serve either or both of two purposes: (1) permit exchange of alkali ions of the base glass and metal ions in the metallic paint or (2) cause fusion of a vitreous flux incorporated into the metallic paint. The firing operation results in better adherence between the metal and glass than any other method (with the possible exception of metal spraying) and as a consequence metallic paint processes have been employed since ancient times for decorative purposes.

The metals most commonly used for this type of metallizing are silver, gold, and platinum, although ruthenium, iridium, palladium, and rhodium may be substituted. High cost precludes the utilization of these latter to any great extent and the applications have been restricted to special purposes.

3. *Metal spraying.* The past few years have seen tremendous increase in the use of sprayed molten metal to build up worn machine parts, such as shafts, and numerous other applications of metal on metal. The extension of this process to the metallizing of glass and other ceramics has not been rapid although the potentialities are great. The method does not differ fundamentally from that of application to metals except that preheating of vitreous materials is desirable to decrease thermal shock and to promote adherence.

Since the metal coatings formed are often thick and non-uniform this method is not likely to prove promising for decorative purposes, although refinements in the process may possibly alter this condition. Industrial uses, however, will eventually be numerous. Coating the surfaces or edges of glass articles or sheets to be joined by soldering has been done commercially, and this type of application will become more extensive. Another interesting use of metal spraying is the manufacture of electric heaters by spraying a "winding" of aluminum or aluminum alloys on a glass plate. The passage of electric current through the winding develops heat by resistance. The same process on a larger scale could be used for heating of homes, offices, etc. where electric power is sufficiently cheap, and this type of heating could be combined with decorative functions of glass, for example, walls and ceilings.

4. *Cathode sputtering and evaporation.* Both of these methods utilize an evacuated chamber in order to convey metal to the surface to be coated. Cathode sputtering, not used extensively today, depends upon the fact that if a high voltage is applied between an anode and a cathode in vacuum the cathode metal travels to the walls of the evacuation chamber and to the surfaces of the work to be coated. Evaporation, on the other hand, is a purely thermal distillation in vacuum.

There are several important advantages to both methods. It is possible to form extremely thin films, which may serve as optical filters as well as electrical conductors. Coatings of metals which cannot be precipitated from solutions can be deposited. Metals and elements which do not lend themselves to other methods of deposition, such as selenium, tellurium, and silicon, can be deposited on any surface. It is also possible to deposit metals, such as platinum and gold, on metals far removed from them in the electromotive series, such as aluminum and magnesium for instance. This cannot be done by electroplating.

The processes, however, are slow and tedious and relatively inconvenient to perform.

5. *Chemical reduction films.* This method of deposition is well known as the "silvering process". Mirrors were formerly made by using an amalgam of tin and mercury but silvered glass mirrors, which date from 1835, have almost entirely replaced the amalgam type.

Technical and patent literature discloses dozens of processes for "silvering" glass, other ceramics, and plastics. Nearly all of these employ the reduction of metal salts to metals by means of organic substances. The bulk of these processes can be classified in terms of the reducing agent as follows: 1. Sugar reduction, 2. Formaldehyde reduction, 3. Rochelle salt (tartrate) reduction, 4. Hydrazine reduction, 5. Reduction by other organic compounds and 6. Inorganic reduction.

Chemical reduction methods have been used to deposit films of silver, copper, silver-copper alloys, gold, antimony, and nickel.

Mechanical Films

The three steps in the process of applying a mechanical conducting film to glass and other ceramic materials are: (a) the surface is roughened, (b) a bonding medium is applied, and (c) the conducting medium is applied. The second and third steps are often combined by mixing the bonding medium and the conducting medium together before application to the ceramic.

(a) *Roughening the surface.* It is not always necessary to roughen the surface of ceramic material prior to application of a mechanical film. In all cases of smooth surfaces, however, such as glass, glaze, enamel, etc., roughening at least slightly is recommended to promote adherence. If the coated piece is to be electroplated later and if a smooth surface is desired coarse roughening of the ceramic surface is to be avoided.

Roughening of ceramics may be done mechanically by sandblasting or chemically by use of hydrofluoric acid. Both methods are satisfactory although chemical roughening is perhaps slightly superior.

Roughening should be followed by thorough cleaning to remove all dirt, chemicals, grease, etc. Washing in

hot running water followed by cleaning with carbon tetrachloride or trichlorethylene is usually sufficient. Treatment with a dilute sodium of potassium hydroxide solution may precede the water washing if necessary.

(b) *The bonding medium.* The simplest type of medium, and easily applied, is a natural wax. Beeswax, carnauba wax, ceresine, and paraffin are most commonly used. These waxes may be applied in melted form or in solution in a suitable solvent. As a rule, a medium of this sort is too soft to serve well as a base for metallizing. Because of this weakness, however, a base of wax is ideal where a form built up by electrodeposition is to be removed from the mold surface.

Solutions of rubber, gutta percha, or asphalt in benzol, turpentine, etc. are conveniently made thick or thin to suit requirements.

With both of the above groups of bonding coatings the conducting medium is generally applied to the coated surface by dusting or brushing. Metal powder has, however, been suspended in a solution of gutta percha in benzol and applied to the surface by spraying or brushing.

Cellulose lacquers, such as cellulose nitrate, acetate, or butyrate, may be sprayed or brushed. Adhesion is good, drying time is rapid, and metal powder may be incorporated before application. The metal-lacquer mixtures should always be relatively fresh.

Natural gums, such as acacia, arabic, dammar, copal, mastic, tragacanth, and shellac, are readily soluble in suitable solvents and permit wide latitude in the proportions of gum, solvent, and conducting medium in the mixture. Shellac has been used very extensively. Often the solution of gum is first applied and then dusted with the conducting medium.

Resins such as phenol-formaldehyde, urea-formaldehyde, melamine, etc., which form hard films when dried or polymerized, may be substituted successfully for the natural gums. Glyptal varnish is also good.

(c) *The conducting medium.* As explained previously, the conducting medium may be dusted on the surface of the bonding medium or may be mixed with the bonding medium. In the case of dusting, finely divided tin, zinc, copper, brass, bronze, or iron may be applied to a warm wax surface or to a tacky, sticky gum surface. Mixtures of powders are sometimes used.

Incorporation of the conducting medium into the bonding medium is more useful for ceramic materials than dusting. Adherence is usually better. Care must be taken, however, to see that the amount of bonding medium in the mixture is not too great. If the dried film is glossy in appearance the metal particles are coated too completely with the bonding medium, and electrical conduction is too poor to permit electroplating.

Leyden jars have been made by coating lightly etched glass with the following:

Bronze powder	1 lb.
Lacquer	1 gal.

After drying, the surface is ready for plating.

The following bronzing mixture may be applied to glass by spraying.

Nitrocellulose lacquer	1 fl. oz.
Lacquer thinner	7 " "
Copper bronze powder	2 oz.

The surface should be dull when dry.

U. S. Patent 2,211,582 (Aug. 13, 1940) specifies a mixture of 70% copper powder and 30% zinc powder with a solution of cellulose nitrate in amyl acetate. When dry, the coating is treated with vapors of hydrochloric acid. The resistance drops to a low value and electroplating can then be performed.

Metallic lead films on glass are sometimes useful, particularly for X-ray filters. These films are formed by adding flake-lead to a binder, such as a natural gum, and applied by brushing, dipping, or spraying. The dried film consists of minute overlapping flakes of metallic lead. The film may be heated to form a continuous film.

Silver sulfide. In this method the conducting medium is silver sulfide rather than a metal. Silver nitrate may be incorporated into the following:

Ethyl alcohol	1 pt.
Silver nitrate	1 oz.
Shellac	4 oz.

This coating is applied to the surface of the ceramic to be metallized and then dried. A second method is to shellac the surface to be metallized, drying the shellac, and then immersing in the following solution:

Silver nitrate	¼ oz.
Ethyl alcohol	2⅔ fl. oz.
Water	1⅓ " "

In both cases the coating consists of silver nitrate suspended in and on a film of shellac. The dried film is exposed to hydrogen sulfide fumes to convert the nitrate to silver sulfide, which is sufficiently conducting to permit electroplating.

Graphite. Graphite coatings, while not metallic, may be electroplated in an acid copper bath. This method is therefore of interest as a means of metallizing glass.

Graphite powder or a mixture of graphite and powdered metal may be dusted onto a bonding medium coating and subsequently plated. An alternative method is to employ colloidal graphite, such as Dag graphite SR-2 (Acheson Colloids Corporation).

Silver paints. Silver paints consisting of finely powdered metallic silver suspended in a suitable medium, such as cellulose ester lacquer, are available (du Pont No. 4530, 4548, 4503, and 4132 and American Ceramic Laboratories Silver Paint No. 25). These are not to be confused with the metallic paints in the following section, which require firing in order to bond to the ceramic. The above silver paints, applied by spraying, dipping, or brushing, are air-dried or baked at moderate temperature (such as 140° C). The films are probably purely mechanical and adherence is due to the binder. Electrical conductivity is extremely high and scratch resistance fairly good. They are ideal for electrodes applied to dielectric test specimens, and measurements show little or no difference in such cases when compared with fired-on silver electrodes. Where not subjected to elevated temperatures and abrasion these coatings should find many uses. They may be covered with a baked lacquer in order to prevent tarnishing by sulfur and to increase scratch resistance, thus making them available for certain decorative applications.

Metallic Paints

Platinum. The simplest type of metallic paint is one in which the conducting medium in the form of a metal-

lic salt is mixed with an essential oil or similar material which is lost in firing. For example, a platinizing mixture for glass can be made by adding 0.2 gram of platinic chloride or chlorplatinic acid to 5 ml each of alcohol and ethyl ether and 4 or 5 drops of turpentine. This mixture is applied to the glass (preferably roughened) and then dried. After drying, the coated glass is gently heated in a Bunsen burner until a film of platinum is obtained. The adherence of this film is so good that a gas-tight seal may be made to it by soldering.

Various modifications of the above method are used. Thus, platinic chloride is dissolved in oil of flowers of lavender or oil of turpentine and a small quantity of apshaltum added. The paint is fired on the glass at a cherry-red heat. Or, a 10% platinic chloride solution equivalent to 1 gram of platinum chloride is evaporated to dryness and dissolved in a minimum quantity of absolute alcohol. The solution is added slowly and with stirring to 6 ml of lavender oil in a container cooled with ice. The solution is then warmed and Burgundy pitch is added until the desired consistency is obtained. Many other variations of the above methods are available.

Platinum may also be applied by incorporating a flux into the mixture. Thus, 1 gram of platinic chloride is dissolved in 3.5 ml of absolute alcohol, 10 ml of a concentrated alcoholic solution of boric acid are added, and finally the mixture is treated with 25 ml of a mixture of turpentine and lavender oil until the desired consistency is obtained.

A metallic paint may be made up by first finely grinding the following:

Litharge	2 grams
Lead borate	1 "
Lavender oil	10 "

Platinic chloride is added until a thin paste-like paint results.

Another formulation is as follows:

6% collodion	3 parts
12% platinic chloride	3 "
ethyl alcohol	3 "
1% bismuth chloride	1 "

A somewhat different method involves treating glass with a mixture containing

Copper sulfate	1 part
Ochre	2 parts

Iron sulfate may be used in place of the copper sulfate and whiting may be substituted for the ochre. In any case the treated glass is heated to 750° F. A thin paint is made up by adding lavender oil to a mixture of

Platinic chloride	50 grams
Litharge	1 gram
Lead borate	1 "

This is applied to the treated glass and heated to 1000° F.

Gold. To secure an even deposit of gold from a metallic paint the metal must be extremely fine. This may be obtained by precipitation from solution. Thus, an excess of potassium hydroxide solution is added to a gold chloride solution until the precipitate redissolves. Mercurous nitrate is added until precipitation is complete. The precipitate is separated from the solution, washed, and then treated with nitric acid to dissolve mercurous salts. After washing and drying the extremely fine gold may be combined with a flux as follows:

Gold	12 parts
Flux	1 part

The flux consists of

Bismuth nitrate	12 parts
Borax	1 part

Gold films may be obtained from gold salts without the use of a flux. Gold chloride is kneaded with sufficient oil of rosemary to a paste-like consistency, and to this paste is added 5 times its weight of oil of lavender. The paint is applied to the vitreous surface and fired at about 900° F.

Another method is as follows: Gold chloride is dissolved in sulfuric ether while sulfur is dissolved in oil of spike. The two solutions are mixed, applied to glass or china, and fired.

Silver. Silver metallic paints nearly always consist of finely divided metallic silver and a flux. Thus, the following mixture is combined with lavender oil to form a paint.

Silver powder	2 parts
Lead borate or sodium borosilicate	1 part

After application, the paint is dried and fired.

More complex formulations have also been used. An example is the following:

Powdered flint glass	6 grams
Lead oxide	6 "
Potassium nitrate	24 "
Borax	6 "
Boric acid	12 "
Silver chloride	1 oz.

A suitable lead borate flux for use with silver powder is made by fusing the following at 500° C in an oxidizing atmosphere.

Red lead	71 grams
Boric acid	29 "
Ammonium nitrate	3 "

The presence of fluorides in the flux results in better bonding to the vitreous surface. A typical formula is

Powdered silver	65.0%
Lead borate	3.5
Bismuth subnitrate	1.5
Lavender oil	30.0

To the above mixture about 10% of barium or lead fluoride is added. The paint is applied to glass and fired at 600° C.

Ruthenium, palladium, rhodium, iridium. Chlorides of ruthenium, palladium, rhodium, and iridium may be substituted for platinum chloride in any of the formulations employing the latter. As an example, the following is satisfactory.

6% collodion	3 parts
12% palladium chloride	3 parts
ethyl alcohol	3 "
1% bismuth chloride	1 part

The firing temperature is 500-750° C.

Another method involves making a mixture of 1 gram of ruthenium nitroso chloride and 1 gram of alpha naphthol which are then boiled in acetic acid. The solution is evaporated to give a resinous mass which is soluble in isoamyl alcohol or oil of lavender. The paint is applied to the glass, dried, then fired to about 400° C.

Salts of iridium, palladium, and rhodium may be employed in the same way. This method is described in U. S. Patents 2,166,076 (July 11, 1939) and 2,328,101 (Aug. 31, 1943).

Metallic films of the above elements are not affected by acids and alkalies. They are excellent for medical and dental uses.

Metal Spraying

This process, in which a stream of molten metal is sprayed in the same manner as lacquers, may be divided into three groups on the basis of whether the metal before spraying is in the form of wire, powder, or in molten form. Special pistols or guns are available for each method. The results obtained by each are equivalent as far as glass and ceramics are concerned.

The Schoop gun can be used with any metal which is available in wire form. The gun in use requires the spraying pistol, wire supply, compressed air, oxygen, and fuel gas, valves, regulators, etc. A small air turbine, reduction gears, and knurled rollers feed wire of uniform diameter into the melting nozzle. In the nozzle the metal is melted by a flame of oxygen and combustible gas (hydrogen, acetylene, butane, etc.). As fast as melted the metal is atomized and carried to the work to be sprayed by means of compressed air, usually a distance of 3 to 6 inches. The nozzle diameters are generally 1 to 1.5 mm, the smaller diameters being employed with the higher melting point metals. A small diameter is recommended also for spraying small areas and larger diameters for large areas.

The Schori gun, similar in general principle to the wire gun, is used with any metal available in the form of fine powder. This gun does not require moving parts as in the case of the wire gun.

In the molten metal type of gun the molten metal is placed in a malleable iron container of the gun, where it is maintained at the correct temperature by means of a burner. This gun is restricted to metals whose melting points are relatively low.

Copper, aluminum, and stainless steel are good metals for use on glass and ceramics. The glass is carefully cleaned to remove dirt and grease, and it must not be touched with the hands after cleaning. The glass is heated to not less than 300° C. The spraying is then done on the hot glass, and the surface should be completely covered before the temperature falls below 300° C. After complete covering the same metal or other metals to the required thickness may be sprayed onto the initial coating even when cold. In order to avoid danger of cracking, however, it is well to complete the spraying while the glass is still hot.

Cathode Sputtering and Metal Evaporation

Cathode sputtering. The conditions for cathode sputtering may vary considerably. The pressure may range from 1 mm to 10^{-2} mm of Hg, and is usually adjusted to give a dark space of about the same length as the distance from the cathode to the surface to be coated. The cathode of course is made of the metal which is to be deposited; the anode is usually aluminum or iron. The potential between cathode and anode, which ranges from 1000 to 20,000 volts, is preferably direct current, although alternating current can be used. The residual gas in the sputtering chamber may be air, nitrogen, argon, hydrogen, oxygen, or mercury vapor. In a tight system the required low pressure can be obtained with a mechanical pump; in a system equipped with a regulating leak a fast mechanical pump or a diffusion pump is used.

A glass bell jar with a hole in the top for the cathode connection is the usual sputtering chamber. Glass is preferred for the base although iron may be used. The work to be coated is placed on an aluminum support (which is heated before use to remove oils which it may contain). A glass tube should, where possible, surround the cathode and the work to be coated. This is advisable to prevent degassing of large glass and metal surfaces under the action of the discharge and thus avoiding possible introduction of harmful foreign substances. The cathode is shaped, as far as possible, so that the boundary of the dark space is nearly parallel to the surface to be coated. A flat cathode is used for a flat surface; a curved cathode for a curved surface. A U-shaped cathode coats both sides of a plate or disc at once. For coating the inside of tubes a central wire cathode is satisfactory, while a tube cathode is good for coating fibers or the outside of tubes.

The first part of the sputtering is likely to be erratic and unsteady. Because of this fact it is advisable to cover with mica the surface to be coated. The mica must be so mounted that it can be moved away by a magnet outside the jar or by tilting the entire sputtering system.

The sputtering rates, in descending order, of metals in residual air are: Pd, Au, Ag, Pb, Sn, Pt, Cu, Cd, Ni, Ir, Fe, Al, Mg. The rates in nitrogen (descending order) are: Ag, Au, Pt, Pd, Cu, Ni. In argon gas the rates are: Cd, Ag, Pb, Au, Sb, Sn, Bi, Cu, Pt, Ni, Fe, W, Zn, Si, Al, Mg. Hydrogen gas, although sputtering rates are very slow, shows the following order: Bi, Te, As, Tl, Sb, Ag, Au, Pb, Zn, Cu, C, Sn, Fe, Ni, W, Co, Mo, Mn, Cd, Al, Cr, Ta, Mg. In oxygen the rates are: Zn, Tl, Ag, Au, Pb, Cu, Sn, Fe, Mo, W, Ni, Cd.

With a residual air atmosphere to give a 5 cm dark space, 1000 to 3000 volts potential, discharge current of 50 milliamperes, 5 cm diameter cathode, 2 to 4 cm distance from cathode to coated surface, it has been found that Sb, Bi, Cd, Au, Pb, Pt, Ag, Sn, and Zn give an opaque coating in 1 hour, Co, Cu, Ir, Fe, Ni, Se, Te produce an opaque coating in 2 hours, Mo, Ta, W in several hours, while Al, Be, C, Cr, Mg, and Si have extremely low sputtering rates. The rates for chromium, aluminum, and silicon are greatly increased in mercury vapor.

Evaporation. Evaporation is much simpler than cathode sputtering. Briefly, the method consists merely of heating a substance in a high vacuum until its vapor pressure becomes 10^{-2} mm of Hg or greater. When this occurs the metal emits molecular rays in all directions. The degree of vacuum required is such that the mean free path of the molecules is greater than the diameter of the vacuum chamber.

The metals (or non-metals in some cases) may be heated in several ways which may be summarized as follows:

1. Induction heating
2. Arc heating
3. Resistance heating

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THE WORSHIPFUL COMPANY OF SPECTACLE MAKERS AND ITS CONTINENTAL ANTECEDENTS

By L. M. ANGUS-BUTTERWORTH

The Inventor of Spectacles

There appears to be a consensus of opinion that the inventor of eyeglasses or spectacles was Salvino D'Armato of Florence, upon whose tomb in the Church of St. Maria Maggiore at Florence there is this inscription:

"Here lies Salvino D'Armato, of the Armati, of Florence, Inventor of Spectacles. God pardon him his sins. A.D. 1317."

It is believed that D'Armato made his discovery about the year 1285. The dictionary of the Academy of Florence contains under the word "Occhiali" (spectacles) the passage:

"Rivalto, a monk of Pisa, in a sermon delivered February 23rd, 1305, made the following statement: 'It is not twenty years since the art of making Spectacles, one of the most useful arts on earth, was discovered. I myself have seen and conversed with the man who made them first.'"

The invention of printing (c. 1430-48), enabling thousands to read who had not done so before, and thus revealing defects in eyesight, was the main cause in the extended use of spectacles. Venice early earned a reputation for the high quality of its spectacle lenses, and there was also a rapid development of the industry in South Germany. There were makers of spectacles in Frankfurt-on-Main in 1450. Strasburg in 1466, and Nuremberg and Regensberg in 1478, the source of the lenses for these towns being conveniently placed glass factories in the Bavarian and Bohemian forests.

Foreign Guilds

By the end of the 16th century there were regular guilds of spectacle makers in Italy, Germany and France. The two principal guilds were those of Nuremberg and Regensberg, being both in South Germany and therefore compatriots, competed strongly with each other. Journeymen of Nuremberg were not allowed to leave that town for Regensberg, and the Councils of the two towns restricted the industry, as far as they could, to their own respective localities. There was a guild also at Venice, and as Venice was expert in the manufacture of glass, while Nuremberg and Regensberg were more expert in the manufacture of frames or mountings, there appears to have been some mutual arrangement under which Venetian spectacles could be sold in Germany and German spectacles in Italy.

The Nuremberg Guild Decrees declare that from 1577 Venetian spectacles were only to be sold by travelling peddlars and other tradespeople in the *streets* of Nuremberg while the home products were allowed to be sold only at their respective manufacturers' shops. The merits of the Venetian lenses were such that the Germans realized that it was to their advantage to ensure a supply of them for their trade. On the other hand, Bavarian glass was well known and appreciated at Venice during the period 1585 to 1618. Von Rohr states that the Venetian practice in mounting the glasses was decidedly behind that of the Regensberg craft.

Guild Laws

The Guilds of Spectacle Makers on the Continent had certain features in common which were afterwards adopted by the Worshipful Company of Spectacle Makers in England. They were organized bodies of craftsmen, consisting of masters, journeymen and apprentices, with definite regulations and by-laws. The guilds carefully regulated the admission of members. Thus, before becoming a full member a candidate had to serve an apprenticeship and to make and present a "masterpiece" for approval. A masterpiece was a piece of work carried out by a workman to enable him to graduate as a master. The guild prescribed the number of journeymen and apprentices that each master might employ, prohibited all outside and unskilled labor, and exacted good conscientious work. One of the main objects of the guilds, at any rate during their earlier history, was to prevent the making and selling of cheap and inferior goods.

Spectacle makers had some curious links with other trades. For example, the Minutes of the English Spectacle Makers' Company contain an entry relating to actions against haberdashers for selling spectacles. This was evidently traditional, for over two centuries earlier haberdashers in France are known to have cooperated closely with the spectacle makers. It is recorded that in a review of merchants and artisans which passed before Louis XI of France in 1465, the spectacle makers marched under the same banner as the haberdashers and the upholsterers. In 1525, however, spectacle makers there were joined to the mirror makers, and when, in 1581, Henry III of France renewed the "Patents of Mastership", the mirror makers, spectacle makers and toy makers were combined in one guild.

English Spectacles

The earliest authentic record of the craft of spectacle making in England appears to be the reference in Newbery's "Dives Pragmaticus", published in 1563, to "Al Spectacle makers for dim sighted eyes" and to "Spectacles made of fine Burral glass." There were at first few craftsmen engaged in the "art or mistry", but their

numbers increased from year to year, and in the early part of 1628 the spectacle makers took the first steps towards obtaining a Charter of Incorporation.

Leading spectacle makers met to consider the steps to be taken to obtain official recognition. They were assisted by one Thomas Copley, who was afterwards named in the Charter as their first Clerk. In July 1628 the Court of Common Council received "a petition to the King's Majesty by Robert Alt and other poor spectacle makers in and about the City of London." His Majesty, as was the custom, sent the petition to the Lord Mayor, then Sir Heneage Finch, and the Corporation of the City, for their report. In November the latter reported that they thought favorably of the request of the Spectacle Makers of London to be incorporated "as like to encourage them in their trade, increase their members, and reform many abuses."

Charles I thereupon granted a Charter and directed the Attorney General to prepare it.

The Charter

All the documents of the Spectacle Makers Company were destroyed in the Great Fire of London with the very fortunate exception of the Charter which was granted in May 1629. This is headed with a portrait of Charles I and is inscribed on parchment. In spite of its use through three centuries it is in good condition.

The Charter provides that the Company may inflict "Pains, Punishments and Penalties (a bright bit of alliteration!) for the reformation in the said Trade and Art or Mistry in the Making of Spectacles of such Abuses, Deceit, and other wrongfull Practices from Time to Time practised or to be practised, in uttering bad or hurtful ware, wherby our loving subjects may be wronged or abused."

A point worthy of notice is that even in mediaeval times the area of a Company's activities was not always confined to the ancient city limits. Thus the Charter of the Spectacle Makers gave them control of all persons exercising the art of spectacle-making "within the realm of England."

The Ordinances

The Charter among other things empowered the Court of the Company to make "Laws, Statutes, Decrees, Ordinances and Constitutions" in writing. This they proceeded to do, and on April 24th, 1634, the Ordinances of the Spectacle Makers Company were submitted to the Court of Common Council, who appointed a Committee to examine them. On November 4th, 1634, it was reported that the Ordinances had been approved and allowed under the hands of the Lord Keeper of the Great Seal and the Lord Chief Justice.

The Bye-Laws and Ordinances, being duly approved and recorded, thereafter became binding upon all Spectacle Makers throughout England. They deal with many matters. Fines were imposed for Masters and Wardens failing to attend meetings of the Court, for not attending to meet the King upon summons, and for members using reviling words or blows. Penalties were fixed for persons found making spectacles by working the glass on only one side. It was laid down that no one should buy glass except in small quantities unless it was offered for the use of the whole society. Quality was maintained by a regulation that no wares were to be sold until viewed and allowed by the Master and Wardens or their deputy, by fines for selling bad wares, and by the condition that craftsmen must pass an examination by the Company upon workmanship to be approved. It was ordered that frames must not be sold without glass, or glasses without frames.

Powers of the Court

The Court of Assistants, acting as a rule through the Master and Wardens, was very active in enforcing its powers for two centuries after the Charter was granted. During that period the Minute Books reveal frequent examples of action taken. Visits were paid to the workshops of members and others to search for inferior work, as for instance when glasses were ground to a sphere on one side only. Faulty glasses were destroyed in large quantities, as also were imported lenses. Delinquents were often fined and sometimes even placed under arrest.

A typical case was that of Nicholas Sheild. In April 1668, the Master and Wardens found at his house in Fenchurch Street 18 pairs of Spectacles made from looking glass and wrought on one side only. Sheild was caught red-handed working upon additional glasses, and was ordered to pay a fiffe of 20s. a pair on the finished spectacles, or £18 in all. He refused to pay and the Court of Assistants of the Spectacle Makers ordered that he should be sued at Common Law. He was arrested and brought before the Lord Mayor, who declared that he must make his submission to the Company. In June, 1668, the Court of Assistants agreed to reduce the fine to £6, and Sheild promised to pay £3 in September and the balance of £3 in December. There are other examples recorded in the Minutes of fines being reduced in this way.

Early in the following year an inspection was made of the shop of Mr. Clarke, a wholesale Haberdasher living against London Wall, and 31 dozen of French spectacles were found there. It is recorded that "the said Mr. Clarke desired that the Wardens would break both frames and glasses of them of his own voluntary and free will, sayeing he would deale no more in them, But the Wardens did onely breake the glasse and lefte the whited copper frames undefaced. But upon his very much complayning of the greate losse he had susteyned by the late dreadful ffire and the losse in the defacing of these 31 dozen of Spectacles, and promising never to deale more in them being Forreyng Spectacles, the Wardens gave him freely Tenne shillings in money, the wch he took very thankfully."

The powers of the Court of Assistants were little exercised after the end of the 18th century, although their disciplinary rights still have all the force of legal authority.

Watch Glasses

In addition to their other interests the Company exercised jurisdiction over the making of watch glasses. This work was reserved for members of the Company, and action could be, and was, taken against any outsider who dared to cut across this profitable arrangement.

The following example, of May 1669, is typical of the kind of case that arose, "John Sheppy, of the parish of St. Buttolph, Bishopgate, London, dwelling in Angell

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BOOK REVIEWS

Statistical Quality Control
By Eugene L. Grant

Marriage without benefit of clergy sometimes leads to unpleasant results. When such a high-brow mathematical science as statistics mates with such ancient concepts of the marketplace as price and quality, it is not surprising if the offspring are sometimes ugly and ungainly. And, indeed, this is what has happened to the subject matter usually called "Quality Control". But now, Eugene L. Grant has taken the awkward hybrid, acknowledged its parentage, and had it properly christened. The result is a graceful virile book of nearly 600 pages properly entitled "Statistical Quality Control".

To the small minority of industrial plants which are now using statistical quality control, the book would seem to be a necessary manual supplementing, or perhaps replacing, a collection of pamphlets, notebooks and self-composed manuals now being used. To the large group of organizations now making exploratory excursions into the application of statistical science to production, the book will be the means of smoothing the way, and will undoubtedly, as the author hopes, save many headaches. To the still larger class who have not used statistics in operation but who will in the future, the book seems to be the logical first step.

But even to those who have no intention of ever applying statistical quality control to their process, the book will be a valuable reference summary of the known methods of industrial mathematics. And to those who have attempted to follow and apply the discoveries of statistics to industrial measurements during the past twenty years, the book seems almost the answer to a prayer.

This happy result follows not from an attempt to write a text on general statistics, but rather from the author's limiting his discussion to those statistical methods that are applicable to industrial production. As would be expected, the greater part of the book is devoted to the four types of Shewhart's quality control charts and the various acceptance sample tables. Each tool is described carefully and fully, the reader being told why it works, how it works, and what to do if it backfires. Frequency distributions are adequately covered, due consideration being given to non-normal distributions. Correlation and other statistical procedure which are applicable primarily to development and research have merely been indicated and the reader referred elsewhere.

A refreshing novelty is the fact that the author makes no attempt to "sell" statistical quality control. No space is wasted describing the fantastic savings made at the Rustless Pick-axe Works. Instead, a profuse collection of carefully described examples is given. Some of these were ill-advised, some salutory; some were bungled and some were not, but all are skillfully commented on with no attempt at glamour. The fact that not all of the examples concern linear dimensions will appeal to process industries.

The author has written the book for what he calls the second highest level of understanding, namely, those who desire to fully understand the basic principles but who do not feel called upon to advance the mathematical frontiers. It is the numerical strength and placement of this level which the author thinks has most to do with the technical progress of an organization. In hitting this level, the author has been unusually successful. The book requires a sympathy towards mathematics rather than a knowledge of the subject. Without having to read a single page, or even footnote, in mathematical symbols, the reader still feels that he is getting the full story from one who understands it, without being talked down to. Indeed, it is the reviewer's opinion that the book is easier reading than many books which purport to appeal to a lower level, and fully as convincing as many which exhaust the printer's font of integral signs.

The paper is about as good as can be expected nowadays, and the typography and book-making come up to the usual high standards of the Maple Press. The few typographical errors have to do with bars and subscripts, and while they are disconcerting, they should not be confusing to the careful reader.

New York and London, McGraw-Hill Book Company, 1946. 563 + xii pp., 9 x 6 in., cloth, $5.00.

Robert F. Ferguson

Metallizing Non-Conductors
By Samuel Wein

This small volume, while designed primarily to cover methods of metallizing organic plastic materials, is an excellent concise summary of the available procedures for metallizing glass and other ceramics.

The chapter on mechanical films is very complete. Bonding mediums based on natural gums, waxes, rubber, lacquers, and gelatin compounds are discussed in detail, with inclusion of many formulas. Methods of applying or incorporating the conducting medium are treated. Most of these methods, at least as far as ceramic applications are concerned, are useful only as a means of obtaining a conducting base on which metal may be deposited by electroplating. In the case of certain silver paints, however, these may themselves serve as electrodes for test purposes.

Chemical reduction films, or "silvering processes", are useful in production of mirrors, and most are so used. Such films may, on the other hand, serve also as conducting coatings upon which metal is deposited subsequently by electroplating. The function of stannous chloride prior to silvering is discussed briefly and several theories for the action of this compound are advanced, but the matter of base exchange with the glass is not elaborated. The Brashear, Rochelle salt, and formaldehyde processes are explained in terms of formulas and procedures. Methods of reduction by other organic compounds are given. Considerable space is devoted to formation by reduction of copper and gold films or mirrors, and deposition of nickel and antimony coatings is treated briefly.

The chapter on cathode sputtering and metal spraying

is much too general to be of specific value to the glass technologist. While cathode sputtering does not have wide application, metal evaporation and metal spraying are extremely important as means of applying metals (and some non-metals) to glass surfaces.

Metallic paints, which depend upon heat to cause reduction of metallic salts and to promote adherence are discussed in detail. Formulas and methods are given for metallic paints of platinum, ruthenium, iridium, palladium, rhodium, gold, and silver. Metallic paints are used widely not only as a means of decorating glassware, pottery, terra cotta, etc., but also as a metallic film to which metals or metallized glass may be soldered to form seals. The formulas given in this chapter are of value for both purposes.

Electroplating is covered briefly and with emphasis only on copper plating.

The list of references at the end of the volume is surprisingly good and constitutes one of the chief values of the book. References to the technical literature are relatively few, but the purpose of the volume is completely practical and is concerned with methods rather than theory. Patent coverage, while plainly not intended to include every patent on metallizing, goes far enough to enable the reader to determine whether a given formula or method is in the public domain or is subject to restrictions.

A few criticisms are pertinent. The explanations are not entirely clear in connection with some methods. The classification into groups of basic processes shows more overlapping than is desirable. Thus, it is questionable whether the silver sulfide and lead sulfide processes should be considered chemical reduction methods. Finally, the paper-bound format of the book is a disadvantage from the viewpoint of permanence, and the price is high enough to justify binding in hard covers if not cloth. It is hoped that this will be done in the next edition.

Metal Industry Publishing Company, New York, 1945, 62 pages, $2.00.

A. J. Monack

AWARD FOR BEST PUBLISHED PAPER TO BE MADE BY ACS

The Preston Laboratories has made a gift of $100 to the American Ceramic Society for 1947, and comparable gifts for 1948 and 1949, which the Society will award as prizes to the authors of the most creditable papers in the field of glass technology.

The award shall be known as the Frank Forrest award in commemoration of Captain Frank Forrest, of the U. S. Army Air Corps, killed over Germany on November 18, 1944. He was previously a part-time student at Antioch College and part-time chemist at the Preston Laboratories.

After the three awards have been given, consideration will be given the question of the continuation of the awards. The money shall be in the custody of the Trustees of the American Ceramic Society, who each year shall appoint a committee of two scrutineers to assess published papers offered for consideration of the award.

Any person may bring to the notice of the committee any suitable paper, but before the committee considers it, the author or all the authors if more than one, shall signify in writing his/their willingness to have the paper so considered and agree to accept the award if made to him/them. Papers, in order to be eligible, need not necessarily have been printed in the publications of the American Ceramic Society, nor need the author, or any of the authors if more than one, be American citizens. A paper, to be eligible, must have been published in one of the two calendar years preceding the date of the award: e.g., to be eligible for the 1947 award, the paper must have been published during either 1945 or 1946. It must be brought to the notice of the committee on or before June 30 of the year of the award. The committee may, of course, bring papers to their own attention, since "any" person may be construed to include members of the committee itself.

The paper must be in the English language and its first publication must have been in a journal of a bona fide scientific or technical society incorporated in the United States of America, Dominion of Canada or in a trade journal of those countries. Publication in a house organ or a government bulletin or the like shall not be construed as satisfactory and if first published in such organs or bulletins, the paper shall be considered ineligible even though later published elsewhere. But, if first published in a bona fide journal or trade paper, subsequent publication (after a lapse of at least three months) in any other medium whatever shall not be considered of itself a disqualification. The subject matter of the paper shall be some matter within the field of glass technology, broadly considered.

Of the committee of scrutineers, no more than one shall be a professor or school teacher and neither shall be a member of any federal government agency or in receipt of any stipend from the U. S. or Canadian governments.

No member of the Preston Laboratory organization shall be eligible for a position on the committee until at least one year after his separation from the Laboratory.

Inasmuch as Frank Forrest himself was a very yonug man, the award shall be made, other things being equal, to a young author; but this shall not debar older men if no really noteworthy papers have been published by younger ones.

THATCHER DELAYS NEW PLANT CONSTRUCTION

Franklin B. Pollock, President of Thatcher Manufacturing Company, has announced that instructions have been issued to hold up construction of the major portion of the new plant which is being built adjacent to the present plant at Olean, New York. Construction will continue only on a small portion of the project, including a warehouse building.

Mr. Pollock stated that the Thatcher management was of the opinion that until labor-management relations were on a sounder basis assuring the economic well-being of the country, it could not proceed any further with the completion of the project.

Increased costs have almost doubled the prospective total cost of the project since it was originally announced with no degree of certainty as to how much further these costs would rise prior to the completion of the project.

BRITISH PLAN BIG GLASS PLANT EXPANSIONS

Major plans for expansion in the flat and shaped glass industries have been announced by leading British firms. Shortages of machinery, labor and other essentials demand that most of these schemes should be long term, rather than immediate.

The Alloa Glass Work Co. Ltd., for instance, plans a development to be completed by 1950, costing approximately £500,000 and involving a 100 per cent in output. Glass has been made in this center in Scotland for the past 200 years, thus demonstrating that the industry there is retaining its continuity and vitality. American machinery is in considerable demand in plans which involve the creation of modern furnaces capable of very great fuel economies.

Another important British company, the British Indestructo Glass Ltd., reported at the annual meeting, W. B. Mitford, Chairman, speaking, that:

"In accordance with the wishes of our Government, we have continued to export a large volume of our goods and with the assistance of many valuable agencies established by us, this foreign business is growing and, in our opinion, will continue to expand. We have, however, passed through a period—entirely beyond our control—when material was in extremely short supply. Despite this, our optimism is strong and is further strengthened by the fact that we have the assurance of Pilkington Bros., Ltd., that we shall get a full share of all available glass and that their extension program will insure that all our estimated requirements will be met.

"In view of the rapidly improving design of motor car bodies, it is my considered opinion that in two years the safety glass in this country will require an entirely new manufacturing technique which will consist of the automatic treatment of glass for the production of laminated or toughened safety glass, flat or curved. An immense amount of technical research has been carried out by the technical staff headed by Mr. Alfred Tillyer and myself, on which it would not be expedient to enlarge. Following my recent visit to America, I formed the opinion that car designers in U.S.A. have turned over practically one hundred per cent to curved glass for the rear windows of their cars, and in another year—that is, with the coming of the 1947 models—several, at any rate, of the American motor-car companies will have adopted curved glass throughout the whole glazing of their vehicles. There is no doubt whatever that the standardization of curved glass for rear lights in America has met with universal approval, and already the American users of motor transport are showing a marked preference for curved glass. In many models in America the superficial area of the rear curved glass window, since its inception, has been increased by 144 sq. in. and that of the windscreen by 239 sq. in. The significance of this is that the driver, as well as the passengers, have a better view and the safety factor is increased. It is also claimed that curved glass permits the body designer a freer hand in design. The curve is at present so slight that little or no distortion is apparent.

"The construction for our Acton factory of a new furnace for the automatic production of toughened safety glass is the result of three years experiment and research, and will, we believe, be the largest automatic toughening safety glass furnace in the world. It will come into full operation shortly and will produce either curved or flat types of safety glass. The furnaces are being built by James Royce Electrical Furnaces, Ltd., and will be fitted with automatic equipment to the design of Messrs. Mackness and Shipley, consulting engineers. Already leading car manufacturers have offered the company sufficient orders to keep the new plant working at full capacity for the next three years, and in view of this demand the directors are considering the advisability of duplicating this automatic plant at an early date so that Indestructo will be able fully to meet the future requirements of the trade.

"Since the cessation of hostilities, extensive renovations and mechanization, plus additions, have been made to our plant. These have resulted in a steadily expanding output which, by the end of this year, should reach a figure 75 per cent in excess of that attained prior to the period of reconstruction.

"The installation of automatic furnaces and ancillary plants will enable us during 1947 to build up an output that will exceed the figures for 1946 by approximately 100 per cent."

SHEFFIELD UNIVERSITY NAMES GLASS TECHNOLOGY HEAD

It has recently been announced that Dr. Harry Moore, Director of research laboratories, Pilkington Bros., Ltd., has been appointed head of the department of glass technology of the University of Sheffield. Dr. Moore is also President of the Society of Glass Technology.

From 1904 to 1907, Dr. Moore attended the Royal College of Science, after which he spent a year as a demonstrator in the physics department of the college. He became a lecturer in physics at Kings' College and remained at that post until 1915. For the next four years, he served the Ministry of Munitions and the Ministry of Labor.

From 1919 to 1933, he was assistant director of research to the British Scientific Instrument Research Association under Sir Herbert Jackson. He succeeded Sir Herbert when he retired. He joined Pilkington Brothers in 1937, resigning his post as Director of Research.

PENN SALT OF WASHINGTON OPENS PORTLAND OFFICE

A new general district sales office of the Pennsylvania Salt Manufacturing Company of Washington has been opened in Portland, Oregon, according to a recent announcement.

The office, located at the company's Portland chemical manufacturing plant, is handling Pennsalt's line of chemicals for industry, chemical specialties and agricultural chemicals.

LeRoy M. Shaneman, formerly with the Tacoma office, has been appointed District Sales Manager in charge of the new office.

INVENTIONS AND INVENTORS

A Summary of Recently Issued Patents of Interest to the Glass Industry

Feeding and Forming

Patent No. 2,412,268 is on a spray device for the shears of a glass feeder and it was assigned to Hartford-Empire Company by William T. Honiss.

It is customary to spray the shear blades of glass feeders for the purpose of cooling and lubricating the blades. It has been usual to employ a spray of air and water sometimes with the addition of other ingredients. Such sprays have tended to rust the blades and foreign matter in the fluid has often obstructed the passages of the spray mechanism. This invention provides a spray which will not rust the feeder parts and which will be free from foreign matter which might obstruct the pipes and orifices. The patent is an improvement over Patent No. 2,230,609 granted to M. M. Cannon, Jr., in that it injects a suitable cleansing, lubricating and rust inhibiting material into the spray while it is directed toward the shear blades in open position. The recommended material is soap, preferably in liquid form, which is said to be a good lubricant and to remove foreign matter from the water and air.

As shown in Fig. 1, shear arms 10 and 11 carry blades 12 and 13 when the feeder is delivering two gobs at a time from outlets indicated at 15 and 16. With the usual single gob feeder, one pair of shear blades and one outlet would be used. The figure shows the shears in open position. The shear arms 10 and 11 are actuated by a rod 17 and a spring 20 as shown in the Peiler patent, No. 1,760,435. Spray heads 22 are arranged to discharge a cooling and lubricating fluid onto the blades when in open position. The spray heads and the means for supplying fluid to them may be the same as shown in the Cannon patent, No. 2,230,609, without regard to the number of blades on each shear arm.

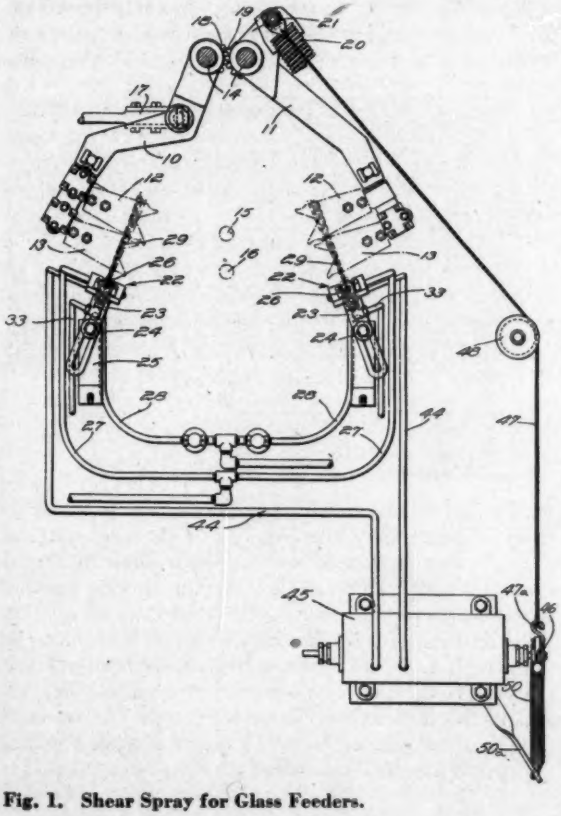


Fig. 1. Shear Spray for Glass Feeders.

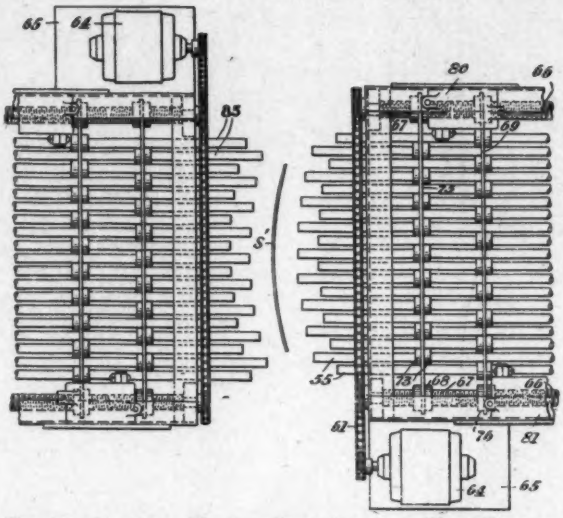


Fig. 2. American Window Glass Company Sheet Tempering Machine.

Each of these spray heads is provided with an additional pipe 44, in accordance with the patent, leading to an injector 45 by which liquid soap is admitted to the spray at the time that the shears are open. This injector may well be a McCord Class B force feed lubricator. The injector is operated by an oscillating arm 46 which, when moved in one direction, will force a charge of liquid soap into the pipes 44 and to the spray heads. This arm 46 is operated by a cable 47 connected to one of the shear arms at 21 and by a spring 50. The amount of soap injected at each squirt may be varied by changing the position of a hook 47a on the arm 46, thus giving it more or less swing.

The liquid soap which is recommended may have other materials added if it is found desirable. A liquid soap sold under the trade name of "Dreen" has been found satisfactory for this purpose, as well as for a shampoo.

Miscellaneous Processes

Patent No. 2,411,701 is on a machine for tempering sheet glass and it was assigned to American Window Glass Company by Theodore G. White, formerly known as Theodor G. Weihs. This patent is a division of the application resulting in Patent No. 2,401,442 on the method carried out by this machine. The former patent was reviewed in the July issue of THE GLASS INDUSTRY.

Fig. 2 is a plan view of the machine as modified to temper curved sheets of glass. A curved sheet is indi-

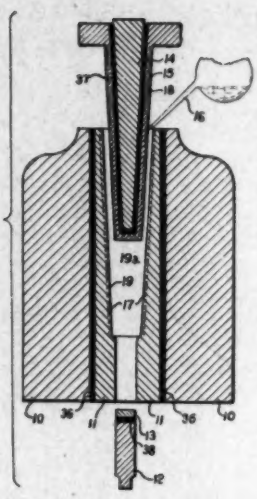


Fig. 3. Method of Making Molds.

cated at S[1] and a series of nozzles 85 are arranged so that they are all at the same distance from the curved sheet, it being noted that there are two sets of these nozzles. On the opposite side of the sheet, there are two sets of nozzles 55. The nozzles on each side of the sheet are actuated so that when one set approaches the sheet, the other set is retracted. All of the nozzles are connected to an air supply so that a continuous blast of air is directed against the sheet from each nozzle.

The mechanism for reciprocating the nozzles is the same on both sides of the sheet. Alternate nozzles are fixed on plates 60 and 75. These plates are reciprocated to move the nozzles to and from the sheet by a motor 64 driving chain 61 which passes around sprockets on the end of screw threaded shafts. Each shaft has a right and left screw thread as shown at 66 and 67. The plate 75 has nuts 68 engaging the thread 67 and the plate 69 has 76 engaging the threads 66. Therefore, while one plate and its connected nozzles move in one direction, the other plate and its nozzles move in the other direction. Limit switches 80 and 81 are positioned so that after the desired travel of the nozzles in one direction, the switches act to reverse the direction of rotation of the motor 64 and, therefore, reverse the direction of travel of the nozzles to and from the sheet S[1].

By this construction, the nozzles on one side of the sheet alternately approach and retract, while those on the other side perform the same way. The sheet is heated in two ovens, the first bringing the sheet to about 900°F. and the second bringing it to nearly the softening point. When the sheet is 3/16 inch thick, each heating operation requires about 2½ minutes. In the construction described, there were 385 tubes and nozzles on each side of the sheet and they were spaced 1 3/16 inches from center to center. In this way, the two sets of nozzles on each side of the sheet produce increasing and decreasing cooling due to the varying distance between the nozzles and the sheet. It is suggested that the closest approach to the sheet be about one inch and that of the stroke of the nozzles about 1⅝ inches. An air pressure of 6.6 inches of water at the nozzle is recommended.

Patent No. 2,411,998 was assigned to Kelly Foundry and Machine Company, Elkins, W. Va., by John F. and William J. Kelly. The patent covers the method of making the mold shown in Patent No. 2,326,730, the two patents having been originally filed in a single application.

There have been numerous bi-metallic molds proposed in which a metal desirable for glass contact forms the surface of the mold cavity and the rest of the mold is made of material having the desired heat conductivity. This patent provides a method of making such a mold in a way which produces a mold of greatly improved quality. This is accomplished by casting a liner of suitable material against a chill wall, cleaning and heating the liner and then pouring cast iron around it to make an integral mold. Of course, press plungers and other glass contacting tools may be made by the same method.

Fig. 3 is a section through a mold, plunger and valve. The larger part of the mold is made of gray or white cast iron 10 which is fused to the nickel-iron alloy inner part 11 having a mold cavity 19a.

The plunger has a cast iron part 14 and an outer layer 15 of the alloy. The valve has a cast iron base 12 with an alloy top 13 fused thereto.

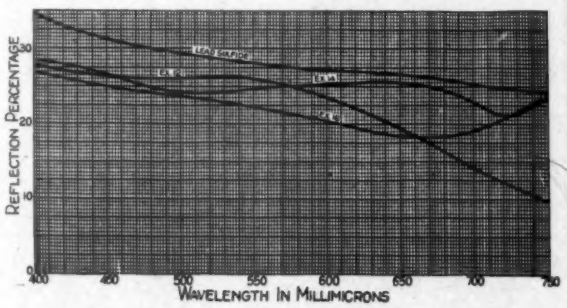
In making this mold, one method is to first case the outer part 10 in a foundry mold with a dry sand core. The cavity is then machined to clean it and it is heated nearly to its fusion point. The nickel-alloy inner part 11 is then poured into the cavity after which the mold cavity 19a is machined in the usual way. The reference numerals 36, 37 and 38 represent a thick wall of alloy formed when the two materials are cast together.

The preferred composition for the insert 11 is:

Element	*Preferred percentage*	*Minimum, per cent*	*Maximum, per cent*
Carbon	3.00	2.25	3.25
Silicon	2.00	1.00	3.00
Manganese	0.70	0.50	1.00
Chromium	3.50	0.00	6.00
Nickel	29.00	20.00	50.00
Molybdenum	1.00	0.00	2.00

Patent No. 2,411,955 is a method of making colored mirrors and it was assigned to Libbey-Owens-Ford Glass Company by the inventors, William H. Colbert and Willard L. Morgan.

There has been a demand for colored mirrors for decorative purposes, but they have been used but little due to the cost and the few colors available. The patent



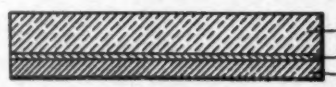


Fig. 4. Colored Mirror.

teaches the manufacture of colored mirrors in which the color is imparted by interference of light rays on a film.

Fig. 4 is a section through a mirror made in accordance with this patent and a diagram showing spectral reflection curves of several such mirrors. Clear plate glass mirrors have a reflectivity value of from 88 to 92 per cent, but colored glass mirrors may have a reflectivity value as low as 25 per cent, or even less, depending on the method and materials used. The sectional view shows a sheet of glass 1, a semi-transparent mirror film 2 and a protective coating 3. Films of lead sulfide

(*Continued on page 47*)

Research Digest

Relation Between Inelastic Deformability and Thermal Expansion of Glass in its Annealing Range

In accordance with experience concerning the behavior of glass at temperatures within its annealing range, Arthur Q. Tool (*Journal of the American Ceramic Society*, September 1946) proposes an equation which relates the various extraordinary heat effects to the inelastic deformability and to the degree of superheating or undercooling. By using this equation in connection with the thermal expansion curves of a glass within its annealing range, certain constants that are related to the coefficient of viscosity and its changes with temperature and the degree of superheating or undercooling have been determined with reasonable results.

The conclusions reached by Dr. Tool are of such interest that they are quoted in full: "Practically speaking, glass at temperatures within and above its annealing range is a purely viscous liquid that is easily undercooled or superheated because its viscosity is so very high. At temperatures far below its annealing range, glass behaves as an elastic solid although there is an intermediate range in which it possesses the characteristics of plasticoviscous material.

"While the condition of an undercooled glass is not one of equilibrium at the actual temperature of that glass, it usually corresponds to one of equilibrium at some temperature within the annealing range and, if the actual temperature is raised quickly enough to that point, the glass will be practically in equilibrium there. A corresponding relation exists between the condition of a superheated glass and some equilibrium temperature within the annealing range. The degree of undercooling (or superheating) is measured by the difference between the actual and equilibrium temperatures.

"The properties of a glass are affected not only by changes in the actual temperatures but also by changes in the equilibrium temperature. Thus, the expansion of a glass increases when the equilibrium temperature is increased as well as when the actual temperature rises, and lowering either temperature increases the viscosity very rapidly.

"The equilibrium temperature ordinarily changes at a perceptible rate only when the actual temperature exceeds the lower limit of the annealing range, but, if the degree of undercooling is very high as in quenched glasses, it decreases at appreciable rates even when the actual temperature is in the temperature interval immediately below the annealing range and within which glasses take on a plastic character.

"The rate at which the equilibirium temperature changes is proportional to the degree of undercooling (or superheating) and also to the inelastic deformability. For the same departure from equilibrium, the rate also increases very rapidly as the inelastic deformability is increased by raising the actual temperature. Since this deformability also increases as the equilibrium temperature is increased, the manner of change in properties is somewhat different when equilibrium is approached from an undercooled condition than when it is approached from a superheated condition at the same actual temperature.

"A glass contracts and evolves heat when equilibrium is approached from an undercooled condition, but it expands and absorbs heat when equilibrium is approached from a superheated condition. The rates at which these heat effects develop depend on the rate at which the difference between actual and equilibrium temperatures is decreased and they are, therefore, controlled by the inelastic deformability.

"In view of the foregoing conclusions, an equation has been proposed that relates these various rates to the inelastic deformability. This equation is applicable to experimental data on the extraordinary expansion and contraction effects and on the exothermic and endothermic effects of glass in its annealing range. Since is it based on the concept that glass is a purely viscous liquid, it is not applicable to data on changes taking place while a glass is within its plasticoviscous stage in which the inelastic deformability increases with the load.

"By using this equation in connection with the usual expansion curves that are obtained by heating a glass to temperatures just above its annealing range, reasonable results are found for constants that are related to the coefficient of viscosity and its changes with the actual and equilibrium temperatures. These constants would make it possible to determine this coefficient if the modulus of elasticity were known for the glass at these high temperatures.

"The behavior of glass at temperatures within and immediately below its annealing range indicates that the various heat effects appear because the balance between the average intrinsic pressure (which arises from the molecular attractions) and the average thermal pressure (which arises from the thermal agitation) is disturbed during superheating and undercooling. This disturbance of the normal balance of the pressures in a liquid causes elastic molecular strains that are abnormal. When such abnormal elastic strains exist in a glass within its annealing range, they relax gradually at rates that are governed by the inelastic deformability which also governs the rates of relaxation or ordinary strains in annealing glass."

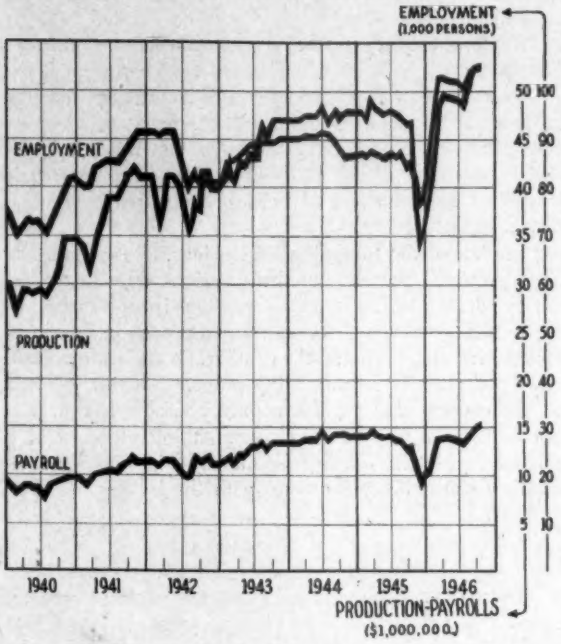
COLORADO FUEL ELECTS VICE PRESIDENT-OPERATIONS

The Colorado Fuel and Iron Corporation has announced the election of A. F. Franz as Vice President in charge of Operations. He will succeed Robert T. Dunlap, resigned.

Before joining the Wickwire Spencer Steel Division of the corporation at Buffalo as General Superintendent, Mr. Franz was associated with the Allan Wood Steel Company. He was appointed Works Manager of the Colorado Division early last year and, in his new position, will have complete charge of operations of the corporation.

CURRENT STATISTICAL POSITION OF GLASS

THE GLASS INDUSTRY'S INDEX



Activity in the glass industry during October 1946 rose about 2 per cent to an estimated $55,000,000, according to the Production Index. The figure reported for September was $54,000,000, and for October 1945, $44,900,000. The October 1945 figure is about 22 per cent below October this year. Output during the January-October 1946 period is $492,500,000 as compared with $465,800,000 reported for the same period in 1945.

Employment and payrolls: Employment in the glass industry during October 1946 continued to rise and reached an approximate total of 105,000 persons employed. During September, the figure reported was a little over 104,000 and, during October 1945, 86,600 persons were employed.

Payrolls rose about 2 per cent for October and were reported to be about $15,500,000 as compared with $15,000,000 during September. During October 1945. payrolls were $12,200,000. During the first ten months of 1946, glass manufacturers have paid out an approximate $128,500,000 in salaries, while, during the corresponding months in 1945, $132,055,000 was paid out.

Glass container production, based on figures released by the Bureau of Census, fell off about 8 per cent for the month of November 1946. The figure reported was 9,609,787 gross as compared with 10,532,857 gross glass containers produced during October 1946. The November 1946 figure, however, is about 7 per cent over that of November 1945—8,902,491 gross. Total glass production thus far in 1946 is 106,405,355 gross, as compared with 96,763,946 gross during the same period in 1945.

Shipments of glass containers also fell off for November. The 9,573,862 gross shipped is about 8 per cent under the 10,516,340 gross shipped during October, but is about 7 per cent over the 8,868,635 gross shipped during November last year. Total shipments made thus far in 1946 are 106,339,511 gross in comparison with 98,546,613 gross shipped during the first eleven months of 1945.

Stocks on hand at the close of November 1946 were 3,904,578 gross, as compared with 3,905,661 gross at the end of October and 3,854,342 gross at the end of November 1945.

(*Continued on page* 36)

GLASS CONTAINER PRODUCTION AND INVENTORY

(All figures in gross)

		Production November 1946	*Stocks November 1946*
Foods; Medicinal & Health Supplies; Chemicals, Household, Industrials; Toiletries & Cosmetics	Narrow Neck	3,033,054	1,180,216
	Wide Mouth ..	*3,468,405	977,954
Dairy Products		327,779	152,706
Home Canning		140,177	260,314
Beverages, Returnable		610,535	367,961
Beverages, Non-returnable		.....	.....
Beer, Returnable		597,887	52,846
Beer, Non-returnable		29,599	15,403
Liquors		998,509	164,120
Wines		421,842	80,269
Packers' Tumblers		.....	22,789
Total		9,609,787	3,904,578

*This figure includes Packers' Tumblers.

GLASS CONTAINER SHIPMENTS

(All figures in gross)

	November 1946
Narrow Neck Containers	
Foods	743,785
Medicinal & Health Supplies	1,055,096
Chemical, Household, Industrials	534,473
Beverages, Returnable	517,364
Beverages, Non-returnable	.....
Beer, Returnable	545,286
Beer, Non-returnable	27,911
Liquors	974,332
Wines	397,302
Toiletries & Cosmetics	634,501
Sub-Total (Narrow)	5,430,050
Wide Mouth Containers	
*Foods	2,978,580
Dairy Products	317,828
Home Canning	72,778
Medicinal & Health Supplies	289,978
Chemical, Household, Industrials	123,145
Toiletries & Cosmetics	119,509
Sub-Total (Wide)	3,901,818
Total Domestic	9,331,868
Export Shipments	241,994
Total Shipments	9,573,862

*This figure includes Packers' Tumblers.

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CURRENT STATISTICS . . . .

(*Continued from page* 34)

Plate glass production for the month of November 1946 fell off about 10 per cent to 20,780,809 sq. ft. from the all-time high of 23,270,656 sq. ft. reported for October 1946. During November 1945, plate glass production was reported to be 543,146 sq. ft. Total production during the first eleven months of 1946 is 191,595,340 sq. ft. as compared with 84,159,103 sq. ft. produced during the same period in 1945.

Automatic tumbler production for the month of November 1946 decreased about 11 per cent to 6,847,675 dozens. During October, 7,762,838 dozens were produced and during November 1945, the figure reported was 6,153,496 dozens. Shipments for November also fell off about 14 per cent to 6,526,513 dozens from 7,657,228 dozens shipped the previous month. During November 1945, shipments were 6,153,396 dozens. Stocks on hand at the close of November 1946 were 5,543,761 dozens as compared with 5,326,415 dozens at the close of October and 5,639,885 dozens at the close of November 1945.

Table, kitchen and household glassware: Manufacturers' sales of machine-made table, kitchen and household glassware for November 1946 dropped a little over 39 per cent to 3,167,937 dozens. The figure reported for October was 5,246,784 dozens, while in November 1945 sales were 2,968,417 dozens. Manufacturers' sales for the 12-month period ending November 1946 are 47,847,508 dozens.

AMERICAN WINDOW GLASS ELECTS DIRECTOR

The election of James H. Clark, of Chicago, to the Board of Directors of the American Window Glass Company has recently been announced. Mr. Clark succeeds J. D. Dyer, resigned.

Mr. Clark has been associated with Lee Higginson Corporation and Laurence M. Marks & Company and in 1939, became a partner of Duff and Phelps and of Duff, Anderson and Clark. In January 1942, Mr. Clark entered the United States Navy and was released from active duty in October 1945.

SYLVANIA NAMES MERCHANDISING MANAGER

F. R. Archer has been named Merchandising Supervisor of fluorescent products for Sylvania Electric Products, Inc. In his new capacity, Mr. Archer will be responsible for the promotion of the company's line of cold cathode fluorescent tubing, long slim fluorescent and cold cathode "K" lamps.

Joining the company in 1940, Mr. Archer has supervised the sales and development of photographic lamps and, during the war, he was Product Manager of Marine lighting, working with the submarine section of the United States Navy.

Prior to joining Sylvania, Mr. Archer was associated with Barkon Frink Tube Lighting Corporation, Westchester Lighting Company and with Henry L. Doherty in a design capacity.

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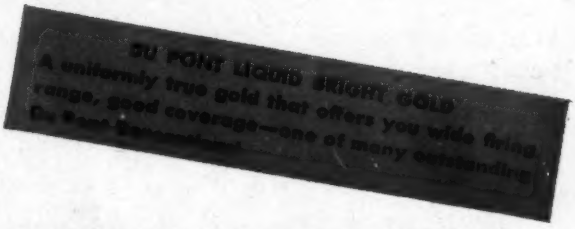
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NEW EQUIPMENT AND SUPPLIES

LEEDS & NORTHRUP ELECTROMAX

Leeds & Northrup Company, 4934 Stenton Avenue, Philadelphia 44, Pa., has announced its new Electromax which is an inexpensive temperature controller and which is said to have high sensitivity and versatility and needs practically no attention. Especially designed for those applications where indicating and recording are not required, Electromax signals and controls only although temperature readings can be taken manually with it at any time.

The instrument consists of a Wheatstone bridge circuit with a vacuum-tube amplifier as the detector. Vacuum tubes are standard, easily-purchased types, require no matching, balancing or other special selection, according to the announcement. It's completely a-c operated—needs no dry batteries or standard cells. The lack of indicating or recording mechanism makes it a practically "zero maintenance" instrument.

The instrument case is only 11 9/16" x 11 1/16" x 9 1/16" and can be mounted wherever convenient. Standard ranges are 0 to 250 F. and 0 to 1000 F. or the corresponding ranges of 0 to 150 C. and 0 to 550 C.

NEW LATHE GUARD

The Standard Safety Equipment Company, 232 West Ontario Street, Chicago 10, Illinois, has announced a new type of lathe and wheel guard which permits complete and continuous work inspection with safety. Called the "Stasafe Chip Guard," it protects operators from the constant danger of flying particles and oil without obstructing work or vision at point of operation. It is adaptable to lathes, shapers, grinding wheels, tool grinders and other types of machines.

The Stasafe Chip Guard is constructed with a strong, all-metal frame and is equipped with a replaceable tough plastic window curved to permit overall work inspection at point of operation. A universal attachment on its base is specifically designed to permit setting the Chip Guard at any angle desired, or move it laterally when in place on a machine. The guard moves with the compound, providing constant protection throughout the entire cycle of operation.

HINGED SECTION FOR CONVEYOR

The Rapids-Standard Company, Inc., Dept. HS-64, 308 Peoples National Bank Bldg., Grand Rapids 2, Michigan, is producing a hinged section for use in a permanent line of standard rapid-wheel gravity conveyors.

The specially-designed section is principally used in bridging an aisleway for passage of personnel, trucks or equipment by providing 36 inches maximum open passageway through a rapid-wheel gravity conveyor line.

The hinged section is opened by lifting the movable part, swinging it upwards and back until it rests securely on the stationary section. The movable part folds back completely out of the way and rests at an angle of approximately 45 degrees to the stationary section.

All parts of the hinged section are of standard rapid-wheel construction consisting of 36 inches of movable section hinged to an 84 inch long stationary section, making a total of 10 feet. The hinge is of simple design and all steel, rugged construction with no rivets, nuts or bolts.

CATALOGUES RECEIVED

The Cambridge Wire Cloth Company, Cambridge, Maryland, has announced the release of a 32-page stock list of wire cloth and metallic screen.

Many "hard to get" items of steel, galvanized, brass, bronze, copper, everdur, inconel, monel metal, nichrome, nickel and the various stainless steel analyses are listed for immediate shipment, subject to prior sale.

The Chas. Taylor Sons Company, Cincinnati, Ohio, has released a booklet featuring Zircon refractories which they believe is the first time such information has been presented in comprehensive form.

Features contained in the booklet are Properties of Zircon Refractories, Zircon Refractories, Zircon Crucibles, Zircon Refractories for the Aluminum Industry, Zircon Hearths, Zircon No. 701 Air-Setting Cement, Zircon for the Glass Industry, Zircon for the Chemical Industry and directions for ordering and using Taylor Zircon Cements and Ramming Mixes.

Sylvania Electric Products, Inc., Electronics Division, 500 Fifth Avenue, New York 18, New York, has made available a data sheet and illustrated reprint tracing the development of the prototype of Sylvania type 135 automatic recording dilatometer.

The data sheet describes calibration of the instrument and provides typical elongation vs. temperature curves for alloys and glass and curves showing thermal critical points. It also gives physical dimensions, weight and electrical requirements of the instrument. The six-page reprint further details operation and design of the prototype instrument.

The B. F. Goodrich Company, Akron, Ohio, has issued a new catalogue leaflet on its sand blast hose, designed specifically for conducting sand and other abrasive materials at high velocities for cleaning, cutting or finishing glass castings, stone and metal surfaces.

The leaflet describes construction of the product, and gives data on sizes, weight per hundred feet and outside diameters.

Woods Engineering Company, Norwalk, Conn., has issued Catalogue Sheet 46-1 describing the improved Woods Model "40" Belt Sander and Tool Grinder. The machine is ruggedly built, it is stated, and is applicable to either machine and wood-working shop production or home work shop use for glass, wood, metals, plastics or rubber. It is used also for tool grinding, deburring and finishing of small parts.

It is easily adjustable for either horizontal or vertical operation and has a platen work area of 5" x 8½" and the standard abrasive belt is 4" x 36". The Catalogue Sheet illustrates the sander and grinder, highlighting its advantages and listing features and specifications.

The Brown Instrument Company, a division of Minneapolis-Honeywell Regulator Company, Philadelphia, Pa., has issued Catalogue No. 5902 featuring its New-Matic Remote Transmission Systems for applications where electrical transmission for indicating, recording and control of temperature, pressure, flow and liquid level is neither desirable nor permissable.

The new 24-page booklet is profusely illustrated and carries several schematic diagrams of typical applications. Its operating features are fully explained and there is a comprehensive description of the component parts which make up the system.

A section of the catalogue is devoted to accessories used in the systems, such as control valves, orifice plates, reducing valves, charts, etc.

Dow Corning Corporation, Midland, Michigan, has issued a revised data sheet featuring DC 2103, Thermoseting Silicone Resin. The revised data sheet has been necessitated by significant improvements in the properties of DC 2103 and additional experience gained through the increasing use of this thermosetting silicone resin, according to the company.

The new data sheet includes tables giving the physical and electrical properties and the chemical resistance of the unfilled DC 2103 resin, as well as recommended procedures for making silicone-glass cloth laminations. Properties of a typical silicone-glass cloth lamination are compared with the properties of cotton-phenolic and glass cloth-melamine combinations. This comparison establishes the fact that DC 2103 is unique among thermosetting resins for its high heat stability, low water absorption, insulating properties over a wide frequency range and for its resistance to carbon tracking.

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* Typical photographs of one of three plate glass melting furnaces constructed for Libbey-Owens-Ford Glass Company by Toledo Engineering Company. This is one phase of service offered to the Glass Industry by Toledo Engineering Company.

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TECO modernization or single unit replacement improves production methods.

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METALLIZING GLASS AND CERAMIC MATERIALS . . .

(*Continued from page* 25)

Evaporation by induction heating is readily accomplished by subjecting granules of metal in vacuum to the action of high-frequency current.

Arc heating as a means of evaporation requires that the metal to be evaporated be in the form of pencils or rods. A high potential is applied, the pencils are brought together to form an arc, and metallic vapor is distilled from the arc.

The considerable advances that have been made in evaporation techniques are due almost entirely to resistance heating. The introduction of the bare tungsten heater and the development of high-speed vacuum pumps have been important factors.

The bare tungsten heater is employed in several ways. 40-mil tungsten wire may be wound on a 5/16 inch mandrel with a pitch of ¼ inch. This heater coil is mounted on heavy copper supports so that the passage of current will not heat the supports. The metal to be evaporated is cut from wire and bent into small U-shaped pieces. These small pieces are crimped to the loops of the heater coil, with the coil in a horizontal position. Evaporation may be done from the fused crimped pieces or the metal may be fused to the coil wire by a preliminary heating before the evaporation is performed. The surface tension of the molten metal in either case keeps almost all of it from falling from the heater wire. Evaporation does not take place from the mass of fused metal at the bottom of each loop but from the adjacent tungsten wire.

A better arrangement than the above is to twist together three strands of 20-mil tungsten wire and form a loop of the twisted wire. This permits higher rates of evaporation with less tendency to burn or to drop molten metal.

The metal to be evaporated is sometimes electroplated on the wire of the heater coil. Since electroplating platinum on tungsten is not performed readily it is advisable in this case to make up a twisted unit consisting of three 20-mil tungsten wires and one 20-mil platinum wire. This unit is then heated in order to evaporate the platinum.

Evaporations are sometimes performed by forming a "bed-spring" coil of twisted strands of tungsten wire, the coil being held in a vertical position with the small loops down. The metal to be evaporated is placed in the "cup" thus formed.

For evaporation of silver and copper, molybdenum or tantalum wire is more satisfactory than tungsten since silver and copper do not wet tungsten readily.

Chromium and gold are evaporated easily from a "cup" such as the one described above. In the case of chromium, pre-fusing in an atmosphere of hydrogen or helium is recommended.

Other heater designs are used. A flat tungsten strip with a small depression in the center to hold the metal is satisfactory. The tungsten strip may also be bent into the shape of a V, with the open end up. By a proper bend in the middle of the V-shaped strip the metal to be evaporated may be confined to the middle of the strip. Another method is to wind a coil of ⅛ inch diameter from 20-mil tungsten wire with a large number of turns close together. The metal to be evaporated is inserted in the form of a length of small diameter into the coil, thus being surrounded by heater wire. Still another method is to form a small vertical coil of tungsten wire and place over it a tantalum cap with a depression for holding the metal or non-metal to be evaporated.

Since certain metals may alloy with the tungsten of the heater coil the tungsten wire should be of sufficient diameter to prevent quick burn-out. Solubilities of tungsten in metals are sometimes limited. Thus, the solubility of tungsten in aluminum is only about 3%. If the solubility of tungsten in the molten metal is too great the heater coil method cannot be used.

For coating large glass surfaces, such as a 100-inch mirror, numerous heater coils must be properly arranged in the evaporation chamber to give complete and uniform coverage.

If the evaporation temperature is defined as the temperature at which the vapor pressure equals 10^{-2} mm of Hg, the following table gives these evaporation temperatures in degrees Kelvin.

Material	*Temperature*	*Material*	*Temperature*
Hg	320° K	Pb	1000° K
Cs	433	Sn	1148
Rb	450	Cr	1190
K	480	Ag	1319
Cd	541	Au	1445
Na	565	Al	1461
Zn	623	Cu	1542
Mg	712	Fe	1694
Sr	811	Ni	1717
Li	821	Pt	2332
Ca	878	Mo	2755
Ba	905	C	2795
Bi	913	W	3505
Sb	973		

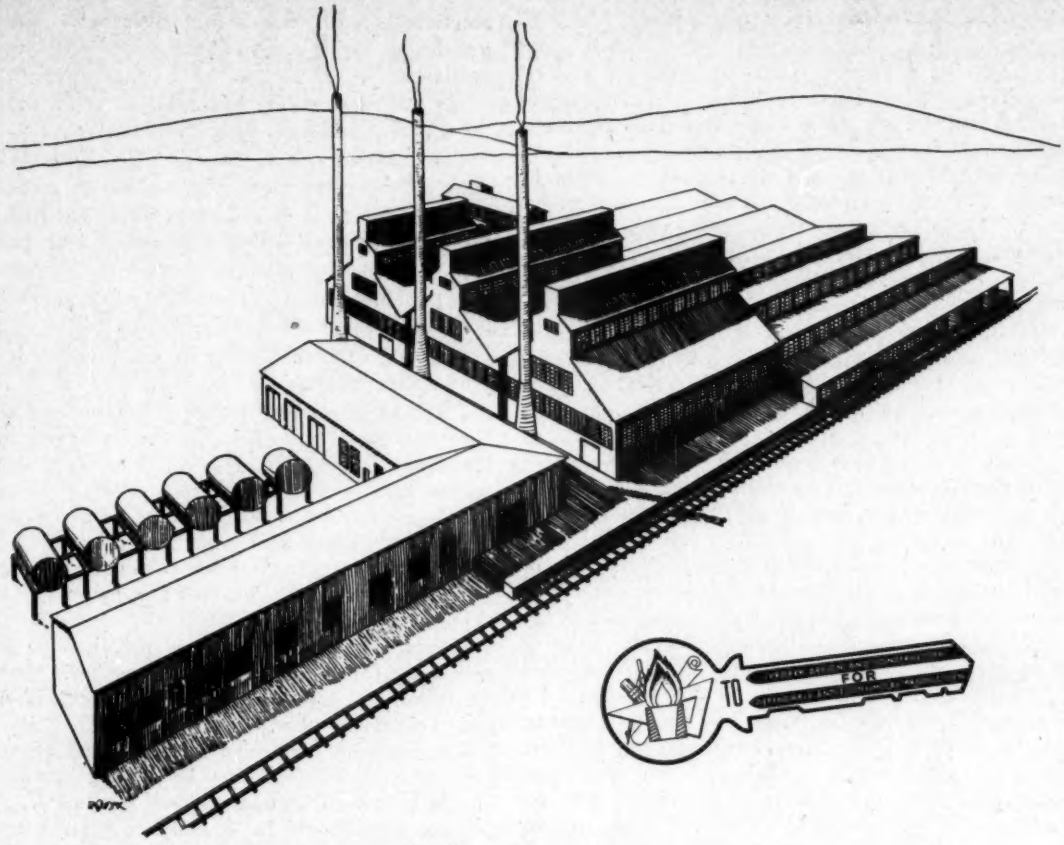
Cleaning glass surfaces. A glass surface for both cathode sputtering and evaporation must be clean and dry. Drying with a towel leaves a layer of contamination, possibly a film of fatty acid from the cotton. Drying may of course be done in a desiccator to avoid the use of a towel or absorbent cotton. A better method is to clean the glass after drying with a towel by means of the action of ions on the glass surface.

Cleaning by ions may be done in several ways. If the hotter, ion-rich portion of a blowpipe flame is passed over the surface of glass to be metallized the adherence of the metal to the glass is surprisingly strong. In the case of aluminum deposited by evaporation on such a "torched" surface the adhesion is so good that Scotch tape can be pulled off the film without loosening the metal from the glass. The same effect is obtained if the final cleaning of the glass surface is performed by exposing the surface to the brush discharge from the electrode of a high-frequency transformer at atmospheric pressure or by exposing the surface to a glow discharge while the evaporation chamber is being evacuated.

Chemical Reduction Films

Preparation of the surface. The surface must be scrupulously clean in order to obtain perfect adherence. Hence, cleaning must be done with extreme care and the

(*Continued on page* 42)



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METALLIZING GLASS AND CERAMIC MATERIALS . . .

(*Continued from page 40*)

cleaned surface must not be touched. Immersion in distilled water until ready for metallizing is recommended.

Non-optical surfaces and edges of glass should be cleaned of rouge and other contaminations with an ink eraser. The glass is next washed with soap and water or, better yet, with Aerosol (or a similar sulphonated detergent) and water. Rinsing is done with distilled water. A mild abrasive action is helpful. This is obtained by rubbing with a pad of wet cotton and precipitated chalk. The glass is now rinsed with water and swabbed with concentrated nitric acid. A final thorough rinsing prepares the surface for the next step in preparation.

As explained in connection with cathode sputtering and evaporation, cleaning by means of ions, particularly by torching the glass, greatly aids the later deposition of metal.

In order to obtain an adherent and uniform film of metal on the surface, the glass is next treated with stannous chloride solution. The concentration may vary, but 5 to 15% is recommended. The application may be made by immersion or by gentle swabbing. The time required is usually not more than three to five minutes. All stannous chloride must be removed by thorough rinsing.

Solutions other than stannous chloride can be used, although results may often be inferior. Acid or alkaline solutions of lead acetate or thorium nitrate may be employed. Alkaline stannic oxide, zirconium nitrate, titanium trisulfate, hydrazine hydrochloride, hydrazine sulfate, hydroxylamine, and titanium trichloride have all been utilized.

Reduction by sugar. The best known sugar reduction is the Brashear process. A reducing solution is made up as follows:

Water	120 ml
Sugar	90 grams
Concentrated nitric acid	48 ml

The solution is boiled and cooled and is then ready for use.

An alternative reducing solution is

Water	120 ml
Dextrose	7.8 gram

If either of the above solutions is to be kept for any length of time before use 175 ml of alcohol should be added.

The sugar in the first formula may be rock candy, tablet sugar, granulated sugar, milk sugar, fruit sugar, etc.

The following solutions are now made up.

Solution A	
Water	300 ml
Silver nitrate	20 g
Solution B	
Water	100 ml
Potassium hydroxide	14 g
Solution C	
Water	30 ml
Silver nitrate	2 g

The steps in the silvering process are as follows:

(1) Concentrated ammonium hydroxide is poured into solution A until dark brown silver oxide precipitates and begins to clear. The precipitate should not quite redissolve.

(2) Add ammonium hydroxide drop by drop until the solution just clears.

(3) Add solution C drop by drop until a definite straw color is obtained.

(4) Since there is some danger of explosion from this point on, goggles should be worn. Add slowly and with constant stirring all of solution B.

(5) Add ammonium hydroxide slowly and finally drop by drop until the solution just clears.

(6) Add solution C drop by drop until a brownish precipitate appears.

(7) Add 120 ml of reducing solution and pour at once over the glass to be silvered. Best results are obtained at a temperature of 18° C. The container for the mirror and solution should be tipped occasionally to stir the solution. The solution soon becomes dark brown and then black and finally a muddy brown color. When the solution begins to clear (10 to 15 minutes) the action is nearly at an end. The solution is poured off and the mirror rinsed.

If additional metal is desired the silvering may be repeated before the first coat becomes dry.

After drying, the silver may be burnished with a small pad of chamois leather.

The danger of explosion in step 4 and after is not great. Silver fulminate may be formed, however, even in dilute solution if sufficient time is allowed. All excess solutions should be poured into a large container and kept acid with hydrochloric acid. Wash waters may be added or they may be rinsed down the drain.

Reduction by formaldehyde. A reducing solution is made up as follows:

Water	6.8 oz.
Formaldehyde	1.4 oz.

Two silver solutions, as follows, are needed.

Solution A	
Silver nitrate	0.7 oz.
Water	33.8 oz.
Solution B	
Silver nitrate	0.1 oz.
Water	3.4 oz.

Concentrated ammonium hydroxide is added to solution A until the precipitate formed just redissolves. Solution B is added until a slight cloudiness is obtained. Five parts of this solution are mixed with one part of the reducing solution and applied immediately to the glass. 68° F is the recommended temperature.

In an alternative method a solution is made up of

0.2 molar silver nitrate	20.0 ml
80% methyl alcohol	0.5 ml

To the above is added 0.5 ml of 40% formaldehyde and the mixture is applied to the glass.

Formaldehyde reduction without careful temperature and chemical control is often troublesome, and this method is not as popular as others.

Rochelle salt (tartrate) reduction. This method includes reduction by Rochelle salt (sodium potassium tartrate), sodium and potassium tartrates, and tartaric

acid. Tartaric acid is said to be superior to the tartrates.

Various methods are used. The following is satisfactory

Water	100.0 ml
Silver nitrate	16.6 g

This solution is made by dissolving the silver nitrate in 50 ml of water, adding ammonium hydroxide until the precipitate formed has nearly redissolved, and making the total up to 100 ml.

Solution B

Water	100.0 ml
Tartaric acid	1.2 g

Equal parts of solution A and B are mixed and applied to the surface to be silvered.

Another method involves making up the following solution first.

Water	1000 ml
Silver nitrate	2 g
Rochelle salt	1.7 g

The silver nitrate is first dissolved in the water, heated to the boiling point, the Rochelle salt is added, the solution is boiled with stirring for five minutes, and finally filtered. If stored, a dark bottle must be used.

The second solution is made up of

Water	100 ml
Silver nitrate	10 g

Ammonium hydroxide is added until the precipitate formed just redissolves. 10% silver nitrate solution is added until permanent darkening is obtained. The solution is then diluted to one liter.

The silver solution and the reducing solution are used in equal quantities.

A tartrate method used for a copper film requires a solution of

Copper sulfate	25 parts
Water	100 parts

To this is added

Rochelle salt	28 parts
Water	28 parts

The copper tartrate which forms is redissolved by adding ammonium hydroxide. One volume of the resulting solution is diluted with one volume of water before application to the glass.

Hydrazine reduction. Three solutions are made up as follows:

Solution A

Phenyl hydrazine	1 part
Water	2 parts

The solution is cleared by warming.

Solution B

Concentrated copper hydrate solution, made by dissolving copper sulfate in water and adding ammonium hydroxide until the precipitate just redissolves.

Solution C

Potassium hydroxide	10 parts
Water	100 parts

Two parts of solution A are mixed with part of solution B and warmed. Warmed solution C is added until a permanent turbidity results. Glass is immersed in this solution and warmed slowly for about an hour.

In another method a 50% water solution of hydrazine hydrate is made. A 5% solution of copper sulfate is added drop by drop and with constant stirring until a golden suspension of colloidal copper is formed. A slight excess of the copper sulfate solution is added and copper is then deposited on the glass surface.

Reduction by other organic compounds. U. S. Patent 2,315,141 (March 30, 1943) specifies that a solution of 40 parts of 0.4 molar silver nitrate solution, 10 parts of 4 molar ammonium hydroxide solution, and 1.2 parts of 2-nitro-2-ethyl-1,3-propanediol is prepared. Forty parts of 0.5 molar barium hydroxide solution are added with agitation. Silver is deposited during the addition of barium hydroxide.

U. S. Patent 1,989,764 (Feb. 5, 1935) describes the following method. Thirty parts of a 0.02 molar silver sulfate solution are heated to 80° C. Five parts of 0.3 molar triethanolamine are added to the heated solution. Continued heating in contact with the glass to be silvered produces a mirror within several minutes.

Reduction by inorganic compounds. Iron sulfate acts as a reducing agent for silver in the presence of as little as 2×10^{-11} gold ion concentration. The gold acts as a catalyst, while halide ions interfere with the effect. Ferric chloride and ferric nitrate have also been used.

The surface to be plated may also be treated with

Phosphorus	1 g
Carbon disulfide	200 ml

The surface is treated with the above, allowed to dry in the light, then transferred to a solution of

Water	1 qt
Silver nitrate	½ oz

Metals other than silver and copper. Most of the standard reduction methods can, with certain modifications, be used with gold, platinum and other rare metals, nickel, antimony, and silver-copper alloys. Typical of these are the following:

For gold mirrors:

Solution A

Water	1½ gal
Gold chloride	1 oz

Solution B

Potassium carbonate	8 oz
Rock candy	1 oz
Formaldehyde	3 drams
Water	1½ gal

The solutions are filtered and mixed just before application to the glass.

For nickel deposition: An alkaline nickel sulfate solution is reduced by tartrates, much as in the case of silver mirrors.

For antimony deposition: U. S. Patent 2,278,722 (April 7, 1942) describes the formation of bright metallic antimony on glass by reduction of antimony trichloride with tartaric acid and formaldehyde.

Electroplating

Electroplating may be considered a secondary method of metallizing glass and other ceramics. It cannot, however, be considered a primary method since it requires in every case that an initial conducting film be applied prior to plating. Any of the metallizing methods already described can be used for deposition of the necessary initial coating.

Any metal which lends itself to electrodeposition can be plated on a metallized film. In the case of low-melting glasses and glass-bonded mica, however, considerable attention must be given to the composition of the plating bath. With glass-bonded mica it is never advisable to use an acid copper plating bath if the ceramic is intended for electrical insulation applications. The same is true for low melting glasses.

The adherence of a composite metal coating (metallized film plus electrodeposited metal) to the ceramic will be determined almost entirely by the adherence of the metallized film to the ceramic. Strong adherence can be expected in the case of metallic paints and sprayed molten metals. In both of these instances adherence is promoted by means of heat. The adherence of mechanical films is determined by the bonding medium employed. Adherence of sputtered and evaporated films is often surprisingly good. Perhaps the poorest adherence occurs when the metal is deposited by means of chemical reduction. The intended use of the electroplated ceramic determines the degree of adherence required, and this in turn indicates in most instances the method of metallizing to be employed.

Theoretical Aspects of Metallizing

Mechanical films. No extensive reports have appeared on the mechanism of adherence between organic materials and silicate surfaces. It is evident from the fact that glue adheres so tenaciously that glass sometimes cracks before the glue-glass bond is broken that adherence is certainly not due to weak bonds of any sort. Such tenacity of adhesion can scarcely be explained on the basis of residual valences or oxygen bonds. All indications point to actual entrance of organic ions or groups into the glass structure. Polar groups in the organic material seem to be necessary for good adherence to glass. A correlated study of organic structures and adherence to glass would be highly revealing.

Metallic paints. In those cases where adherence of a metallic paint is due to fusion of a flux contained in the paint the mechanism is not difficult to visualize. The flux, being a glass, becomes part of the main glass body, at least superficially.

When metallic paints which contain a volatile or non-vitreous temporary binder are used the reason for adherence is not quite so clear. The temperature of firing is sufficient to increase thermal agitation many fold over the values at room temperature. The forces which hold ions in the glass, already relatively weak in the case of network modifiers, are still further weakened. Interchange between network modifier ions in the glass and metal ions from the paint are therefore possible. This action would be similar to the exchange between silver or copper ions and alkalies in the glass when silver and copper stains are applied to glass. Regardless of method, it seems fairly conclusive that metal ions enter the glass structure.

Metal spraying. If it is assumed that a metal oxide is essential to sealing a metal to glass, it is then possible to postulate that the molten metal becomes at least partially oxidized during its passage from nozzle to glass. The oxide thus formed is soluble in glass.

If, on the other hand, it is admitted that metals will seal to glass without the presence of oxide to form a graded seal of *metal:metal oxide:metal oxide in glass:glass* (and there is a good evidence that oxides are not essential to seals), then the mechanism of adherence must be ionic as in the case of metallic paints. If this is so, the source of the ions is not difficult to determine. In accordance with the Drude-Lorenz theory a metal consists of positive ions surrounded by an "electron gas". The molten metal contains positive ions. These ions could remain as such during the passage from nozzle to glass, and the action would then be one of heated metallic positive ions impinging with considerable force upon a hot glass surface. The action thereafter could be one of base exchange with the glass or possibly reduction of the metal ion to the metallic state in the glass by acquisition of electrons from ionic oxygen in the glass, the gaseous oxygen then escaping from the glass.

Cathode sputtering and evaporation. Since the application of high potential or high temperature is involved in both of these methods, the distilled metal probably consists in large part of metal ions. The impingement of these ionic rays on the glass surface would be similar to the action of metal ions proposed above to explain adherence of sprayed metals. There is a difference, however, in the fact that the glass is not heated. Presumably, at least in part because of this fact, adherence is much weaker. The adherence is probably purely superficial.

Chemical reduction films. In connection with these methods it was explained that the glass is first treated with a solution of stannous chloride. The action in this case seems clearly to be one of base exchange with the glass. The presence of tin ions in the prepared glass surface facilitates the adherence of the metal to be deposited. The relation between the tin ions and the deposited metal is not known with certainty. The bond is weak and may consist merely of metallic bonding between two metal ions.

NOTE

Every effort has been made to cite patent numbers and dates in all cases where a patent is still active. Where no patent number is given it is reasonable to assume that no restrictions on the formulas and methods exist. In order to avoid danger of infringement, however, it is well to investigate patent literature in all cases of contemplated use.

DRAKENFELD PRESIDENT WITH COMPANY 50 YEARS

Scott J. Courtney, President of B. F. Drakenfeld & Company, Inc., recently marked his golden anniversary with the company. He joined the organization in September 1896, twenty-seven years after the company's founding. Mr. Courtney became Secretary-Treasurer in 1925 and held that position until 1931 when he was elected President.

At a testimonial dinner in his honor, Mr. Courtney traced the growth of the company from its inception in 1869. He recalled that in the early days the company was principally engaged in the marketing of imports of various kinds and the rapid development of the nation's glass and ceramic plants in 1920 led the company into the manufacture of colors and special chemicals.

IMAGINATIVE USE OF GLASS IN THE GIANT QUEEN ELIZABETH

When the decorators of the 83,673-ton Cunard White Star liner *Queen Elizabeth* planned the palatial interiors of the world's largest ship, they considered glass a key material in accomplishing their objectives of dignity, architectural lightness and elegance.

Their overall scheme called not only for vast quantities of glass but also for unique and imaginative use of it with the result that it serves distinctive ends, such as panelling and wall surfaces, in addition to the every-day purposes of illumination and table ware.

Glass as commonly used is remarkable on the *Queen Elizabeth* by the great amount required. The huge vessel has 2,000 portholes and windows, while larger windows provide sweeping ocean views from lounges and sheltered promenades. There are some 30,000 electric lamps in the vessel, and the inventory of its catering department includes thousands of glass items.

Unique among the functions of this material on the ship is the wall surfacing of the large air conditioned cabin class lounge. It combines cloudy vellum hide, silver bronze and a special material made from spun glass laid between sheets and silvered on the back, which serves to diffuse light through the room.

The airiness of the lounge is enhanced by two maps of the northern and southern hemispheres deeply engraved on molded glass. Electric light fittings of silver bronze and decorated glass add to the artistic appearance of this lounge, at the after end of which is a raised terrace with a balustrade of silver bronze and glass.

A considerable amount of decorated and illuminated glass add life and interest to the large air conditioned first class restaurant, while in the forward starboard private dining rooms off the main restaurant (one of three such rooms), Jan Juta, a British artist, has designed a glass panel for a lighted recess on the inboard side of the room.

Mr. Juta has also done some work for the forward bulkhead of the first class ballroom which is lined with quilted satin. A deep recess occurs in the center of the bulkhead, and he has lined it with decorative glass showing monkeys, flowers and other jungle life scenes. The central portion of the ceiling in this room is lined with gold mirror and contains elaborate equipment for colored lighting effects.

Lighthouse lenses provide illumination and decoration for the first class movie theater, while in the veranda grill, the dance floor receives floodlighting from an illuminated decorative glass balustrade surrounding it. Mechanically controlled colored lighting is arranged for in the ceiling and behind the orchestra recess, and at each of four corners of the central section of the room is a large screen designed by Mr. Juta.

Glass performs attractive service in both swimming pools of the *Queen Elizabeth*. In the first class pool illumination is provided by a continuous trough of light set in nickel alloy with sandblasted glass panels over the pool, and by a series of "porthole" lights set in the surrounding walls.

Glass is featured in the cabin class swimming pool in a clear panel at the foot of the principal stairs. It is fenestrated in bronze and etched with sea motifs executed by Hector Whistler.

A decoration out of the ordinary is a glass bas relief done by Norman Forest in the cabin class smoking room on the promenade deek. It is one of nine, each executed in a material used in construction of the *Queen Elizabeth*. Steel, wood, copper, bronze, aluminum, lead, white metal and rubber were the other mediums used here. The electric light fittings of this room are of Florentine bronze and decorated glass, with some of them having shades of fluted sheet plastic.

The cabin cocktail bar has illumination from curved lines of fluorescent lighting, and an illusion of sunshine at night is furnished by internal windows, glazed with spun glass of pale yellow and laminated between sheets of clear glass.

Behind folding doors of golden Amboyna in the cabin drawing room is an altar for the celebration of Catholic Mass. Over the altar is a clear glass panel lit by concealed lighting and backed with a sheet of black opaque glass. On the panel, Mr.Whistler engraved a Madonna and Child, visible only when the panel is illuminated.

The two principal mirrors of the cabin dining room were etched by Margot Gilbert in summer and winter carnival designs, while a simple mirror treatment, framed in silver bronze, has been applied to the hatch running through this restaurant. Glass was also effectively used in circular, illuminated discs placed in floodlit bays, the brilliance of which compensates for the lack of sidelights in the room. The discs are etched in flower motifs and are outlined in light.

The tourist dining room also makes attractive use of glass in a large decorated panel at the forward end of the room. An electric clock with a glass dial is superimposed on the panel.

The most prominent feature of the tourist winter garden is a large glass screen mullioned in silver bronze and etched with the "Birth of Life" by Ralph Gowan. Jardinieres for fresh flowers are grouped below the screen and surround glass columns in the center of the room, which is lit by circular ceiling fittings and by indirect lighting which illuminates the screen.

As glass lends itself admirably to the decor of the *Queen Elizabeth* so it makes for the comfort and convenience of the huge vessel. The staterooms are all fitted with handsome mirrors and illuminated by ample, easily accessible lights from the liner's vast host of lamps.

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G.C.M.I. MEETING . . .

(*Continued from page* 20)

Bottles stated, among other details of the Committee's work, that the New Manual of Standards for Dairy Containers had been completed. He also discussed in some detail regulations pertaining to weights and measures. In connection with this phase of the committee's work, Mr. Lamb's report stated in part: "Attendance at meetings of weights and measures officials and conferences and discussions thereat have been continued by representatives of the Committee. After preliminary consultation with weights and measures officials of several states, it was deemed appropriate and advisable to invite representative officials to visit some of our milk bottle factories to gain at first hand an understanding of our mutual problems. The party consisted of the chief weights and measures officials of Massachusetts, Connecticut, Rhode Island, New Jersey, Pennsylvania and the City of Detroit. In the plants inspected by this group where the difficulties of operating under the present nonuniform weights and measures regulations involving numerous duplications of molds, separate inventories of ware, etc., were pointed out at close range. The group also witnessed the square milk bottle operations at a large dairy plant. At the conclusion of the meeting, the Specifications and Tolerances Committee of the National Conference of Weights and Measures, four of whose members were among the group, went on record as favoring the adoption of a pattern or mold number which would be uniform for all states and would replace the present separate state seals.

"This suggested bottle marking scheme was then developed into an all-inclusive plan for identification of milk bottles and their makers which will be uniform throughout the industry after such time as it has been accepted by officials throughout the country. Briefly, it requires that each bottles shall bear three identifying marks: 1) Manufacturer's name or trademark; 2) The capacity of the container; and 3) A symbol of letters indicating the pattern or mold design of the bottle.

"In operation, the manufacturers would register their trademarks with and supply master samples of each mold design and size bottle to the weights and measures officials of the various states. Thus, since all states would recognize the same identification markings, the unnecessary duplication of mold equipment for various states would be eliminated."

A report of a meeting of the Glass Container Manufacturers Institute would really not be complete without mention of the excellent work of the various nine standing Committees of the Institute. The work of these Committees touch every phase of the problems of the industry and the reports of the committee chairmen clearly indicate the meticulous effort put forth by each Committee.

• The Trenton Section of the American Ceramic Society recently held its third meeting of the Fall Season. Philip Dressler, Swindell-Dressler Corporation, spoke on "New Developments in Control and Design of Tunnel Kilns." The annual organization meeting has been planned for January 24 and, at this time, officers will be elected and installed for the coming year.

INVENTIONS AND INVENTORS . . .

(Continued from page 32)

have been found to give attractive results. The films are deposited on the glass by a chemical process which must be greatly slowed down in order to give good results. In this way, the thickness of the film is determined by the time of deposition. Very complete directions are given in the patent as to the use of different materials and the method forming the film.

The following table gives 16 examples of the colors produced by coating of different thicknesses and the figure shows the spectral reflection curves of lead sulfide and examples 12, 14 and 16.

Example No.	Time of forming, minutes	Color	Total percent reflectivity	Total percent transmission	Spectral minimum	Film thickness, microns	Wave factors	No. of times ray reflected
1	2.3	Bluish gray	33.8	45	7,500	0.024	$\frac{\lambda}{8N}$	2
2	3.3	Pale yellow	35.7	42	4,000	.026	$\frac{\lambda}{4N}$	1
3	4.2	Bright yellow	34.4	40	4,400	.028	$\frac{\lambda}{4N}$	1
4	5.2	Orange yellow	31.7	37	4,700	.030	$\frac{\lambda}{4N}$	1
5	6.1	Red yellow	28.2	35	4,950	.032	$\frac{\lambda}{4N}$	1
6	7.7	Purple red	24.9	33	5,250	.034	$\frac{\lambda}{4N}$	1
7	8	Red purple (mauve)	21.6	30	5,500	.036	$\frac{\lambda}{4N}$	1
8	9.4	Purple	21.2	28	5,900	.038	$\frac{\lambda}{4N}$	1
9	10.6	Purple blue	20.9	26	6,300	.040	$\frac{\lambda}{4N}$	1
10	12.6	Clear blue	19.8	23	6,850	.044	$\frac{\lambda}{4N}$	1
11	13.3	Blue green	20.0	21	7,300	.046	$\frac{\lambda}{4N}$	1
					4,600	.046	$\frac{5\lambda}{16N}$	1
12	14	Grayish pale yellow.	21.8	19	4,800	.047	$\frac{5\lambda}{16N}$	1
13	14.4	Grayish yellow	23.2	18	4,950	.048	$\frac{5\lambda}{16N}$	1
14	15.6	Grayish red	24.8	17	5,200	.050	$\frac{5\lambda}{16N}$	1
					7,200	.050	$\frac{3\lambda}{8N}$	2
15	18.5	Grayish purple	24.8	16	5,800	.056	$\frac{5\lambda}{16N}$	1
16	23.2	Silvery blue	21.8	12	6,700	.065	$\frac{5\lambda}{16N}$	1

Patent No. 2,412,925 is a method of making synthetic jewels such as used in some watches and other instruments. The patent was assigned to Stupakoff Ceramic & Manufacturing Company of Latrobe, Pa., by Semon

FOR SALE

GLASS PLANT, CHICAGO HEIGHTS, ILLINOIS

By order of the United States District Court for the Northern District of Ohio, Western Division, Owens-Illinois Glass Company offers for sale as a unit all real estate, buildings, machinery, production equipment (not including molds), tanks and furnaces (except experimental machinery and furnaces) located at Chicago Heights, Illinois, and which were a part of the assets acquired by Owens-Illinois Glass Company from Kimble Glass Company on July 1, 1946.

In accordance with the order of the Court such property is offered for sale for cash to any purchaser approved by said Court, subject to prior sale, at the fair market value of said property as a glassware manufacturing plant, as determined by an appraisal made by The Lloyd-Thomas Company, which said appraisal has been duly filed with the Clerk of said Court at Toledo, Ohio., where it may be inspected. Additions and improvements made to the property described above since July 1, 1946, and prior to consummation of sale are not included in the appraised value aforesaid but are offered for sale as a part of the unit for an additional consideration equal to the cost thereof to Owens-Illinois Glass Company.

In connection with the sale of the property and additions and improvements thereto above described, Owens-Illinois Glass Company will assign or cause to be assigned to the purchaser thereof for the consideration hereinafter set forth, all its rights in and to the following machinery and equipment leased from Hartford-Empire Company situate on said premises on July 1, 1946, to-wit:

4—4 head I S machines with feeders, revolving tube drives and motors, and variable speed drives and motors

1—5 head I S machine with same

2—36" x 74' lehrs, gas fired with top vertical discharge, motor driven steel plate exhaust fan, and all regular equipment

The consideration to be paid by the purchaser to Owens-Illinois Glass Company for the assignment of its rights in the leased machinery aforesaid shall be cash in such an amount as will reimburse Owens-Illinois Glass Company for a fair proportion of any and all payments made in connection with said leased machinery by Kimble Glass Company or Owens-Illinois Glass Company which may be considered as costs of installation, advance payments for minimum annual royalties, license fees, parts, insurance and taxes.

In the event of such sale, possession will be delivered not later than six months after the consummation of such sale to a purchaser approved by the said Court.

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Fig. 5. Method of Making Synthetic Jewels.

H. Stupakoff. The method may also be used in the manufacture of such things as crucibles, wire drawing dies, etc. These articles are usually made from aluminum oxide, although many other materials may be used, including high temperature glasses.

In one use of the invention, that is, for making instrument jewels, a refractory metal shell 8 (Fig. 5) is packed with finely powdered aluminum 10 which may have added material to impart any desired color. A core 9 is centrally positioned in the shell to form the hole in the jewel. The shell is then heated to the fusing point of the aluminum in a non-oxidizing atmosphere. The metal shell and core are disintegrated by oxidization or other means, thus leaving a cylinder with a hole through the center. The drawing is tended to show the manufacture of a jewel for use as a bearing, but the shape and size of the piece has been distorted so as to show the method more clearly.

O-I DISPLAY AT CANNERS CONVENTION

The exhibit of the Owens-Illinois Glass Company at the annual Canners Convention in Atlantic City, January 19-24, will occupy the entire stage at Convention Hall. Owens-Illinois display specialists have designed a giant neon-lighted clock, eight feet in diameter, with a moving pendulum carrying a Duraglas Jar as one of the features in the exhibit.

Each swing of the pendulum makes an electrical contact that flashes on and off the slogan, "The Swing Is to Glass", lettered on an illuminated sign 50 feet long.

Highlighting the exhibit are four display windows 12 feet long and 40 inches high with each featuring a step in the flow of glass containers from the glass factory to the home. The four scenes are: 1) Miniature glass-making plant; 2) Photographic reproductions of high speed glass handling operations in processing plant; 3) Grocery store scene with an actual shelf stocked with colorful glassed food in the foreground; and 4) Home kitchen showing refrigerator filled with glassed merchandise.

OPTICAL SOCIETY WINTER MEETING ANNOUNCED

The winter meeting of the Optical Society of America is scheduled to be held at the Hotel Pennsylvania, New York City, on February 20, 21 and 22, 1947.

The Program Committee for the forthcoming meeting is arranging a number of special features that will be listed in later announcements. Those intending to submit abstracts are requested to do so as quickly as possible.

HEISEY RESUMES "TABLE TALK" PUBLICATION

A. H. Heisey & Company, Newark, Ohio, has resumed publication of its house organ "Table Talk." The house organ circulates among sales people, buyers and others interested in retail selling and promotion of table glassware.

"Table Talk" will present new Heisey products as well as new developments in production and glassware design. Publication of the house organ had been suspended during the war years.

R. R. UNDERWOOD ELECTED DIRECTOR OF AMERICAN WINDOW GLASS

The American Window Glass Company has announced the election of R. R. Underwood to the Board of Directors at the annual meeting of the stockholders. He succeeds A. E. Niemann.

Mr. Underwood is the chief executive for some eleven glass container manufacturing companies, known as the Knox Group, with plants located throughout the country. He has been identified with the glass container business most of his life. He is connected with a number of civic organizations and is a Director of two banks in northwestern Pennsylvania.

AGA ANNOUNCES SALES CONFERENCE

The A.G.A. Sales Conference on Industrial and Commercial Gas, sponsored by the Industrial and Commercial Gas Section of the American Gas Association, will be held at the Copley Plaza Hotel in Boston on March 17, 18 and 19, 1947, according to a recent announcement.

A program has been tentatively outlined by the Program Committee. It has been planned to devote one day to a commercial session, one day to an industrial session, with one day in between to a combination of both and general subjects. A reception to those attending the Confcrence will be sponsored by the G.A.M.A.

PAUL FRED OF FOSTER-FORBES DIES

Paul M. Fred, Sales Manager of the Foster-Forbes Glass Company, died after an illness of several months. He had been a patient of the Marion General Hospital.

Mr. Fred has been a resident of Marion, Indiana, for 30 years. He served as Sales Manager of the Standard Glass Company prior to its merger with the Foster-Forbes Glass Company. During World War I, Mr. Fred was a lieutenant with an artillery regiment and was awarded the Purple Heart for wounds received in action.

Survivors are the widow, Vera; daughter, Gloria; mother, Mrs. John J. Fred; and a sister, Mrs. Edward E. Quirk.

G-E DRI-FILM FOR USE ON GLASS

According to a recent announcement by General Electric Chemical Department engineers, use of G-E Dri-Film water repellent material on area type flow meter glass windows has resulted in improved visibility and reduction of maintenance requirements.

It was further stated that recent tests revealed that 100,000 gallons of crude oil passing through a meter in a ten-day period failed to affect the treated glass surface. This is in contrast to weekly cleaning operations on the untreated surface.

According to the engineers, the Dri-Film water repellent material used for the application was applied to the glass surface by wiping with a cloth followed by polishing with a dry cloth.

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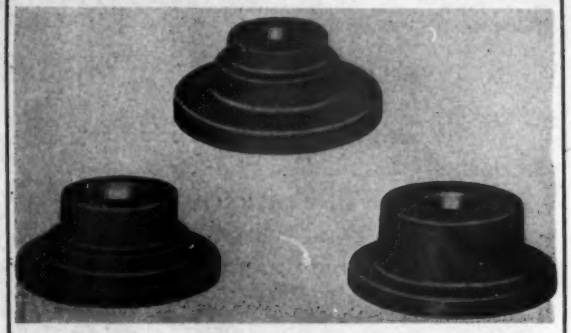

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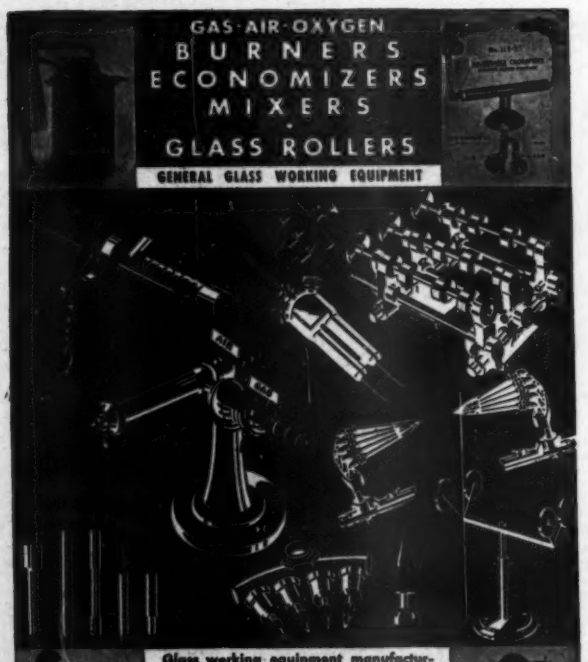

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WORSHIPFUL COMPANY OF SPECTACLE MAKERS . . .

(*Continued from page* 27)

Alley there, being a weaver by Trade, and using the Trade of Spectacle-making by the grynding of watch glasses by himselfe, wife, and servants depending on him, doth here in Court promise at two monethes end to leave the grynding of glass by himselfe, wife, or servant, or els is willing to be prosecuted at Lawe for the using of the Trade of Spectacle-making. And the reason why he doth desire 2 monethes tyme, is because he hath a youth wch is not yet bound to him, unto whom he is by agreement to ymploye at this Trade, being hired for 2 monethes, so that untill that warning be expired he cannot leave the Trade. And after came into Court and saith he is now intended to sell his Tooles for this worke unto Charles . . his servant, who is to goe into Holland to use them there."

The Arms of the Spectacle Makers

A coat of arms was granted to the Spectacle Makers in 1739. The arms have been altered a little, and now consist of a blue shield on the upper part of which are two pairs of gold spectacles, with a set of prisms in their natural colour. Below these are a pair of gold compasses opened to form a chevron that encloses a terrestrial globe in its proper colours.

The motto associated with these arms is "A Blessing to the Aged." The thought is happily expressed, and the use of English is a pleasant change to the mongrel Latin so frequently used in such cases.

The crest of the Company shows two raised arms, with sleeves spotted with stars, holding a serpent entwined to form a circle, in which is represented the sun.

The members of the Company are not only manufacturers of Spectacles, but also constructors of the various instruments by which applied science is conducted, and by which the Mathematician is assisted in his labours. By their instruments the Astronomer and Geographer elucidate their knowledge, the Surveyor maps lands, and the Sailor crosses the trackless ocean. So that in the coat of arms the compasses are intended to denote Mathematics with the globe under them representing Astronomy and Geography. In the crest the sun is included as the source of light, heat and vitality, with the encircling serpent as an emblem of eternity. However impressive the scientific sundries may be, however, it would appear that the most appropriate feature of the arms is the two pairs of Nose Spectacles.

The prisms were added to the original arms in 1810, following the great progress made during the 18th century in the more scientific manufacture of optical instruments. The prisms, for demonstrating the theory of light and colour, led to the invention of the achromatic telescope in 1758 by John Dolland, F.R.S., whose descendants had a remarkable record in that his son, grandson, and great-grandson were Liverymen of the Spectacle Makers Company, two of them living to attain the honourable position of Father of the Company.

Animal Spectacles

We may notice that perhaps the benefits of wearing spectacles are not confined to human beings, even if we do not quite accept the story of the man who fastened

green-tinted glasses before the eyes of his horse, so that the animal might think the old straw in its manger was fresh grass.

In January, 1888 it was reported that a correspondent of the *Manchester Sporting Chronicle*, thinking that his horse was short-sighted, had his eyes examined by an oculist, who certified that the horse had No. 7 eye, and required concave glasses. These were obtained and fitted on to the horse's head. At first the horse was a little surprised, but rapidly showed signs of the keenest pleasure, and "he now stands all the morning looking over the half-door of his stable with his spectacles on, gazing around him with an air of sedate enjoyment; when driven his manner is altogether changed from his former timidity, but, if pastured without his spectacles on, he hangs about the gate whinnying in a plaintive minor key. If the spectacles are replaced he kicks up his heels and scampers up and down the pasture with delight."

Examinations

Although the Spectacle Makers Company discontinued for a period their systematic examination and certification of craftsmen they undertook new duties towards the end of the 19th century, under which candidates are examined in a different way, and diplomas awarded accordingly. It was in 1896 that Mr. W. H. E. Thornthwaite, Fellow of the Royal Astronomical Society, then Upper Warden of the Company, prepared at the request of the Court a scheme for the examination of members of the Optical profession.

The scheme was considered by a Committee consisting of the Lord Mayor of London, who was then Master of the Spectacle Makers Company, the two Wardens of the Company, Lord Bearsted, the President of the British Optical Association, a member nominated by the Astronomer Royal, and certain others. The Committee met at the Mansion House under the presidency of the Lord Mayor, and after various sittings a final scheme was prepared which was adopted by the Court of the Company in 1897. The plans were put into operation in January 1898, and examinations then constituted have been held without break down to the present day in general and visual optics.

RECEPTION AT A.C.S. OFFICE

During the meeting of the Ohio Ceramic Industries Association in Columbus, a reception was held at the office of the American Ceramic Society for the President, J. E. Hansen, and the new Technical Secretary, R. L. Stone.

J. E. Hansen, Director of Service, Ferro Chemical Corporation, is President of the Society for the year 1946-1947. Mr. Stone has recently joined the staff of the Society as Technical Secretary, formerly having been with the Stupakoff Ceramic and Manufacturing Company. He was also a department head at North Carolina State College.

The group which attended the reception was the largest number to be present at any year in which this affair has been held.

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